INSTRUCTION BOOK

FOR

SIGNAL GENERATOR SG-15/PCM

AND

TEST SET TS-140/PCM

MANUFACTURED BY

CONNECTICUT TELEPHONE AND ELECTRIC CORPORATION

ORDER NOS. 24635-PHILA-49 AND 21672-PHILA-50

16 OCTOBER 1952

THESE ADDENDA WILL REMAIN IN EFFECT ONLY UNTIL THE INFORMATION IS PUBLISHED IN AN OFFICIAL DEPARTMENT OF THE ARMY PUBLICATION.

ADDENDA

17 JUNE 1953

ADDENDA TO INSTRUCTION BOOK FOR SIGNAL GENERATOR SG-15/PCM AND TEST SET TS-140/PCM

The following information modifies the instruction book for Signal Generator SG-15/PCM and Test Set TS-140/PCM, published on Order Nos. 24635-Phila-49 and 21672-Phila-50. The serial numbers of the equipment covered in this addenda are:

Name	*Serial Number*
Signal Generator SG-15/PCM	1 to 1154 incl.

Personnel using this equipment and having custody of this instruction book, will enter suitable notations beside each affected paragraph and figure in the instruction book to indicate the presence of this supplementary information.

Page 2. Par. 4. Make the following change in subparagraph c:

Change the type of electron tubes V5, V6 from 6V6Y to 6V6GTY.

Page 6. Fig. 5. Change 6V6Y to 6V6GTY.

Page 27. Fig. 9. Make the following changes in figure 9:

Change the value of capacitor C3 from 200 uuf to 220 uuf.

Change the value of capacitor C7 from 2200 uuf to 300 uuf.

Page 27. Par. 46. In subparagraph *a* (1), change the second sentence to read: Unlike capacitors C2 and C3 in the tank circuit of tube V1, capacitors C10 and C11 in the tank circuit of tube V2 are variable temperature-compensating capacitors with a negative coefficient of 500 parts per million per degree Centigrade.

Page 29. Fig. 11. In figure 11, change the value of resistor R33 from 22K to 27K.

Page 32. Fig. 13. In figure 13, change the type number of power amplifier tubes V5 and V6 from 6V6Y to 6V6GTY.

Page 32. Par. 51. In the first sentence of subparagraph *a*, change 6V6Y to read: 6V6GTY.

Page 33. Fig. 14. Add the following to the figure caption of figure 8:

(In equipments having serial numbers 44 through 1154 inclusive, the value of resistor R44 is changed from 200 to 250 ohms. Equipments having serial numbers 1 through 43 inclusive are not affected by these changes.)

Page 47. Fig. 23. Change the tube numbers under tube sockets X5 and X6 from 6V6Y to 6V6GTY.

Page 52. Par. 75. In subparagraph *c*, change L1 to L2 in each of the four places in which it appears.

Page 54. Fig. 26. Delete figure 26 and substitute the new figure 26:

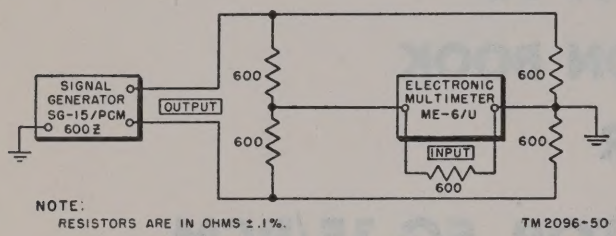

Figure 26. Adjusting longitudinal output, test circuit.

Page 61. App. II. Par. 2. Make the following changes in paragraph 2:

Change the value of capacitor C3 from 200 uuf to 220 uuf.

Change the reference symbol C11 to read: C10, C11.

Change the reference symbol C2, C10 to read: C2.

Change the type number of resistor R45 and R46 from RC30BF393J to RC20BF823K.

Change the type number of resistor R28 and R32 from RC20BF472K to RC20BF104K.

Change the type number of tube sockets X1 thru X13 from TSB8T101 to TS101P02.

Change the type number of toggle switch S1 from ST22N to ST52N.

Change the type number of electron tubes V5 and V6 from 6V6Y to 6V6GTY.

Page 87. Fig. 29. Make the following changes in figure 29:

Change the value of capacitor C3 from 200 uuf to 220 uuf.

Change the value of capacitor C10 from 4.5-25 uuf to 4-30 uuf.

Change the value of resistor R33 from 22K to 27K.

Change the type numbers of power amplifier tubes V5 and V6 from 6V6Y to 6V6GTY.

Add the following to the figure caption of figure 29: *(In equipments having serial numbers 44 through 1154 inclusive, the value of resistor R44 is changed from 200 to 250 ohms. Equipments having serial numbers 1 through 43 inclusive are not affected by these changes.)*

THESE ADDENDA WILL REMAIN IN EFFECT ONLY UNTIL THE INFORMATION IS PUBLISHED IN AN OFFICIAL DEPARTMENT OF THE ARMY PUBLICATION.

ADDENDA NO. 2

15 February 1954

ADDENDA NO. 2 TO INSTRUCTION BOOK FOR SIGNAL GENERATOR SG-15/PCM AND TEST SET TS-140/PCM

The following information modifies the instruction book for Signal Generator SG-15/PCM and Test Set TS-140/PCM, published on Order Nos. 24635-Phila-49 and 21672-Phila-50. The serial numbers of the equipment covered in this addenda are:

Name	Serial Number
Signal Generator SG-15/PCM	1 to 1154 incl.

Personnel using this equipment and having custody of this instruction book will enter suitable notations beside each affected paragraph and figure in the instruction book to indicate the presence of this supplementary information.

Page 32. Fig. 13. In figure 13, change the value of capacitor C35 from 7-45 UUF to 5-50 UUF.

Page 61. App. II. Par. 2. Make the following changes in paragraph 2:

Change the description of resistors R45 and R46 to read: RESISTOR, fixed; comp; 82,000 ohms ±20%; JAN type RC20BF823M.

Change the value of capacitor C35 from 7-45 UUF to 5-50 UUF.

Page 87. Fig. 29. In figure 29 change the value of capacitor C35 from 7-45 UUF to 5-50 UUF.

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WARNING

Heavy voltages are carried in the wiring of this equipment. These voltages are dangerous to life.

Be careful when examining the wiring side of the equipment. When repairing or replacing parts on a particular circuit, remove the power plug to avoid possible electrocution.

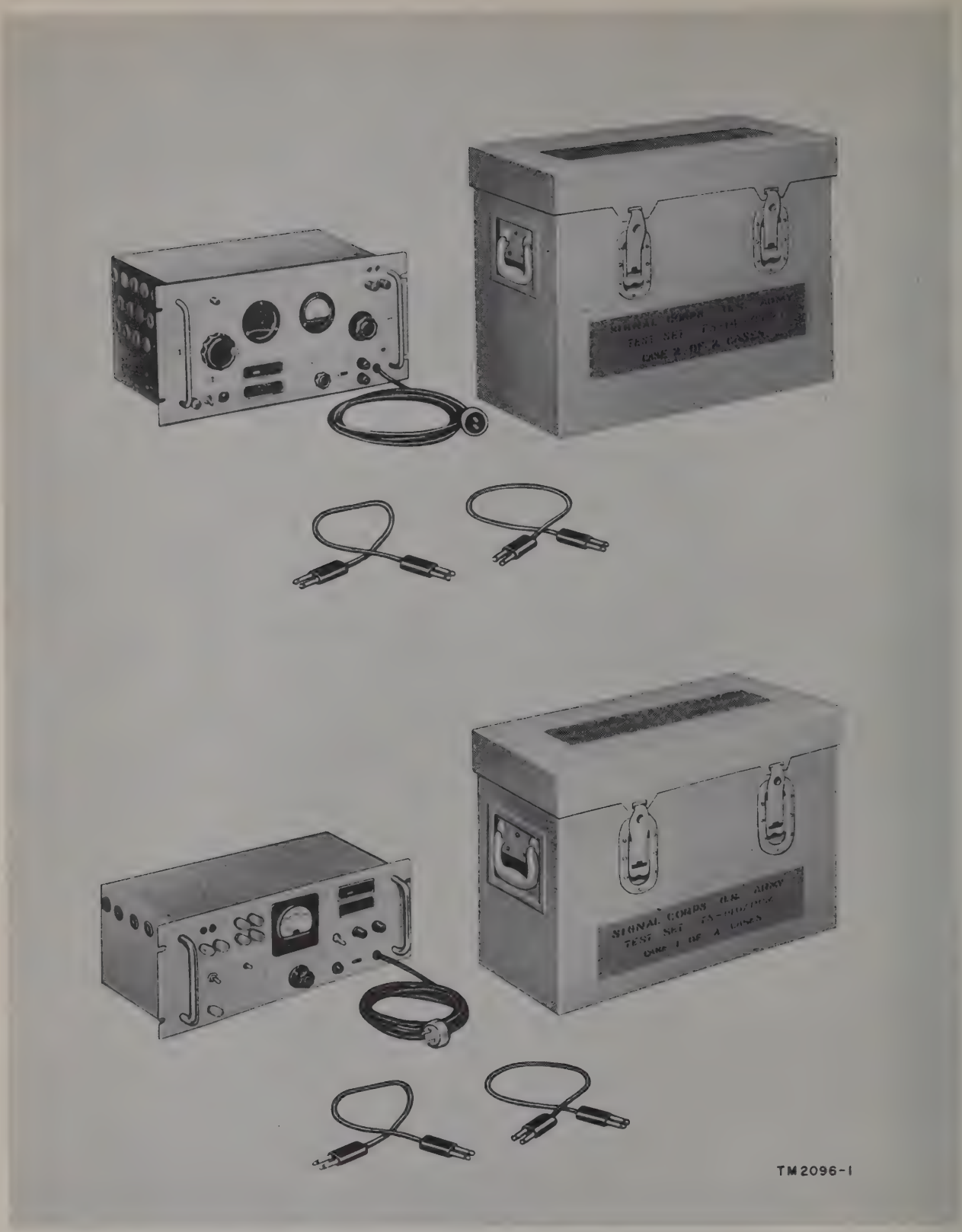

Figure 1. Test Set TS-140/TSM — Signal Generator SG-15/PCM (top) and Decibel Meter ME-22/PCM (bottom).

Note. This instruction book will be replaced by TM 11-2096 which, when published, will be listed in SR-310-20-2.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. These instructions are published for the information and guidance of the personnel to whom Signal Generator SG-15/PCM is issued. They contain a physical description of the equipment, operating instructions, organizational maintenance information, the theory of operation, repair of the equipment, instructions for removing the equipment from service and repacking for shipment or limited storage, and instructions for demolishing the equipment to prevent enemy use. In addition, chapter 3 contains instructions for the operation of Signal Generator SG-15/PCM with Decibel Meter ME-22/PCM as Test Set TS-140/PCM. These instructions apply only to Signal Generator SG-15/PCM and Test Set TS-140/PCM.

b. Appendix I contains a list of references, including supply catalogs, technical manuals on associated equipment, and other available publications applicable to the equipment. Appendix II contains an identification table of parts.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army equipment:

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745-45-5 (Army), NAV DEPT SERIAL 85POO (Navy), and AFR 71-4 (Air Force).

b. DA AGO Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in SR 700-45-5.

c. AF Form 54, Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Material Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in SR 700-45-5 and AFR 65-26.

d. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. Signal Generator SG-15/PCM (fig. 2) is a portable, heterodyne-type, vacuum-tube oscillator which provides a source of testing power for transmission measurements of carrier equipment and wire and cable lines. The signal generator is capable of supplying an output of —54 through +26 dbm (decibels referred to 1

milliwatt in 600 ohms) over a frequency of 200 cycles through 35 kilocycles. It has an output impedance of 600 ohms balanced, and the equipment can be operated from a power source of 115- or 230-volt, 50- to 70-cycle ac (alternating current). A dial, adjusted by a FREQUENCY control, indicates the output frequency of the equipment. The signal generator contains two attenuators. The stepped attenuator, operated by a COARSE DBM control on the front panel, provides for the selection of output ranges in eight steps of 10 db (decibels) each, from —50 through +20 dbm; a ZERO OUTPUT position also is provided. The variable attenuator, adjusted by a FINE DBM control, permits adjustment of the output power within a range of —4 through +6 db as read on the OUTPUT LEVEL meter on the front panel. The output of the signal generator is the sum of the reading of the OUTPUT LEVEL meter plus the attenuation setting of the COARSE DBM control.

b. Signal Generator SG-15/PCM also may be used as a source of testing power whenever there is a requirement for an audio oscillator or a signal generator in the same frequency range.

c. Signal Generator SG-15/PCM may be used with Decibel Meter ME-22/PCM as Test Set TS-140/PCM (fig. 1). The signal generator is used with the decibel meter when portable apparatus is required to provide a source of testing power and to measure received testing power. Gain or loss may be measured directly by Test Set TS-140/PCM since the readings of both the signal generator and the decibel meter indicate power in dbm.

4. Technical Characteristics

a. General

Frequency range ....200 through 35,000 cps.
Frequency
accuracy .....±10 cps in range from 200 through 1,000 cps.
±20 cps in range from 1,000 through 2,000 cps.
±50 cps in range from 2,000 through 35,000 cps.
Power output .....—54 dbm through +26 dbm ±.5 db.
Output impedance ..600 ohms ±5% at 1,000 cycles and 600 ohms ±10% at all other frequencies.

b. Power Requirements

Voltage .....115- or 230-volt ac ±10%.
Frequency .....50 to 70 cps, single phase.

Figure 2. Signal Generator SG-15/PCM.

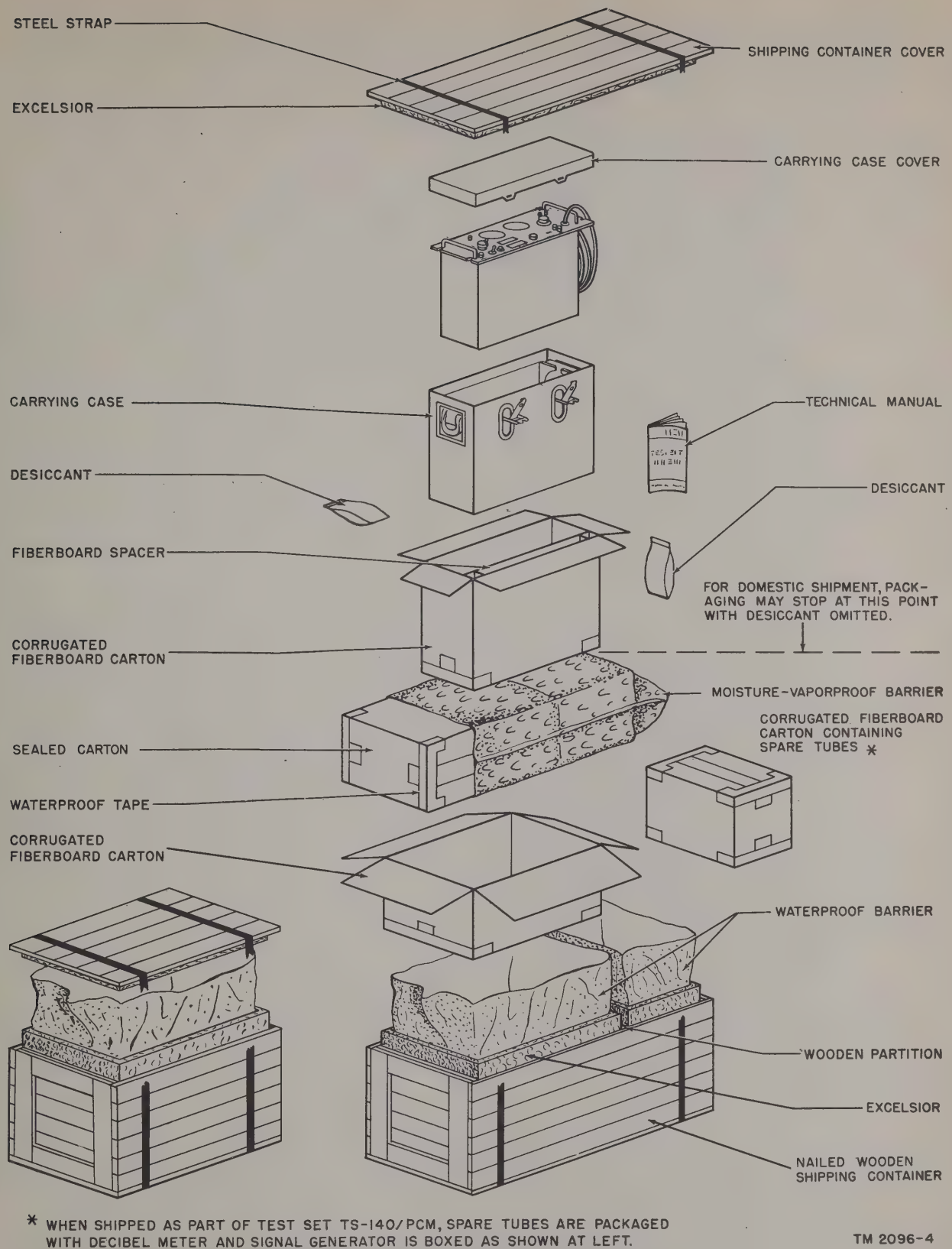

Figure 3. Signal Generator SG-15/PCM, packaged for domestic and oversea shipment.

c. TUBE COMPLEMENT

Quantity	Type	Function	Ref Symbol
3	6J5	100-kc oscillator, variable frequency oscillator, and 3d amplifier.	V1, V2, V3
1	6SL7GT	4th amplifier and phase inverter.	V4
2	6V6Y	Power Amplifier.	V5, V6
2	6SJ7	1st and 2d amplifier.	V7, V8
1	6SA7Y	Mixer.	V9
1	6SQ7	Voltage control amplifier.	V10
1	OC3/VR105	Voltage control regulator.	V11
1	6L6GAY	Voltage control.	V12
1	5Y3GT	Full-wave rectifier.	V13

5. Packaging Data

Signal Generator SG-15/PCM may be shipped shipped as a single item (subpar. *a* below) or with Decibel Meter ME-22/PCM as a part of Test Set TS-140/PCM (subpar. *b* below). The equipment may be packaged for either domestic or export shipment (fig. 3). When Signal Generator SG-15/PCM is shipped with the decibel meter as Test Set TS-140/PCM, the shipping container containing the signal generator is designated CASE 2 OF 2 CASES.

a. PACKAGING OF SIGNAL GENERATOR AS A SINGLE ITEM. (1) *Domestic shipment.* When packaged as a single item for domestic shipment, the signal generator is placed in Carrying Case CY-712/PCM with all operating and spare tubes mounted in their normal positions. The carrying case cover then is fastened and the unit is packed in a corrugated fiberboard box sealed with paper tape. A copy of the instruction book also is packed in this carton. When packaged for domestic shipment, Signal Generator SG-15/PCM is 21⅜ inches long, 16-15/16 inches deep, and 12⅞ inches high. It displaces approximately 2.69 cubic feet and weighs approximately 90 pounds.

(2) *Export shipment.* When packaged as a single item for export shipment, the signal generator is placed in Carrying Case CY-712/PCM with operating tubes in position and spare tubes removed from their mountings inside the cover of the equipment. The carrying case cover is fastened and the unit is placed in a corrugated fiberboard box with a copy of the instruction book and several bags containing silica gel. The fiberboard box is sealed, the corners are blunted, and the box is placed in a moisture-vaporproof barrier and in a second fiberboard box which is sealed with adhesive. The outer box is wrapped in waterproof barrier material. The packaged signal generator then is placed in a nailed wooden box lined with excelsior. The spare tubes are packaged in individual cartons and packed in a corrugated fiberboard box. The box of tubes is wrapped in waterproof barrier material and placed in the wooden box next to the signal generator but separated from it by a wooden partition. The cover is nailed in place on the shipping container and the box is strapped with metal bands. When packaged as a unit for oversea shipment, the signal generator is 43 inches long, 24¼ inches deep, and 23¾ inches high. It displaces approximately 13.72 cubic feet and weighs approximately 160 pounds.

b. PACKAGING OF SIGNAL GENERATOR AS PART OF TEST SET TS-140/PCM. (1) *Domestic shipment.* When packaged for domestic shipment as part of Test Set TS-140/PCM, the signal generator is packed as described in subparagraph *a* (1) above and shipped with one Decibel Meter ME-22/PCM.

Note. For packaging instructions for the decibel meter, refer to the instruction book covering Decibel Meter ME-22/PCM.

(2) *Export shipment.* When shipped oversea, as part of Test Set TS-140/PCM, the signal generator is packed as described in subparagraph *a* (2) above. The spare tubes, however, are packaged with those of Decibel Meter ME-22/PCM and are packed in the shipping container with the decibel meter. When so packed, the wooden box containing the signal generator is designated CASE 2 OF 2 CASES which contain the complete Test Set TS-140/PCM. Case 1 contains the decibel meter and the spare tubes for both units.

6. Table of Components

The following table gives the unpacked weights and dimensions of the major components of Signal Generator SG-15/PCM.

Quantity	Name of Component	Dimensions (in.)			Weight (lb)	Volume (cu ft)
		Length	Depth	Height		
1	Signal Generator.	19	13	8¾	52	1.24
1	Carrying Case CY-712/PCM.	21⅛	16	12¼	30	2.7
2	Switchboard patching cords.	24				
1 set	Spare fuse and tubes.					

Note. This list is for general information only. See appropriate publications for information pertaining to requisition of spare parts (Note, app II).

7. Description of Components

a. SIGNAL GENERATOR SG-15/PCM. (1) Signal Generator SG-15/PCM (fig. 4) is a self-contained unit mounted in a metal case provided with a dust cover. The front panel is slotted at both ends to permit rack mounting on a standard 19-inch rack, and metal handles are provided at either end of the front panel for convenience in carrying the unit. A carrying case with a shock-mounted rack is used for transporting the signal generator and may be used as a semipermanent mounting. The unit has a gray enamel finish.

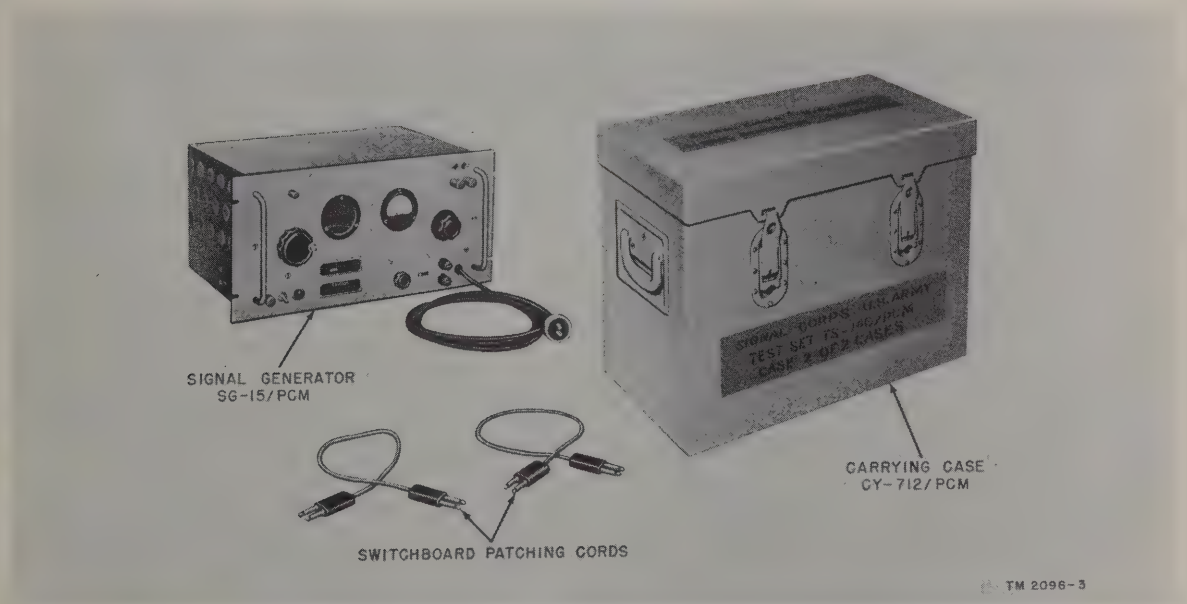

Figure 4. Signal Generator SG-15/PCM, components.

(2) All of the operating controls, jacks, and terminals for external connections are available on the front panel of the signal generator. A meter which indicates the output level of the unit and a circuit protecting fuse mounted in an extractor post holder, also are located on the front panel. The cover over the top and rear of the equipment case and the bottom plate are removable. All of the parts and assemblies mounted on the chassis and on the back of the front panel can be reached for maintenance purposes when the cover and the bottom plate are removed.

b. CARRYING CASE CY-712/PCM. Carrying Case CY-712/PCM (fig. 4) is an aluminum case with a smooth, gray enamel finish. The case is used for storing the equipment and for transportation. It is provided with a shock-mounted rack for semipermanent installation of the signal generator and a compartment for holding the technical manual. The detachable cover contains clips for storing two switchboard patching cords. Two flush-type handles are provided, one on each end of the case. The cover is fastened by four flush-type spring fasteners.

c. CORDS. Two switchboard patching cords are provided with each signal generator. The cords are 24 inches long, excluding terminations, and are equipped with twin plugs at each end. The cords are stored in the cover of the carrying case.

d. OPERATING SPARES. A spare fuse (fig. 2) in an extractor post holder is mounted below the circuit fuse on the front panel. A complete set of spare tubes (fig. 5) is mounted on a panel inside the top of the cover.

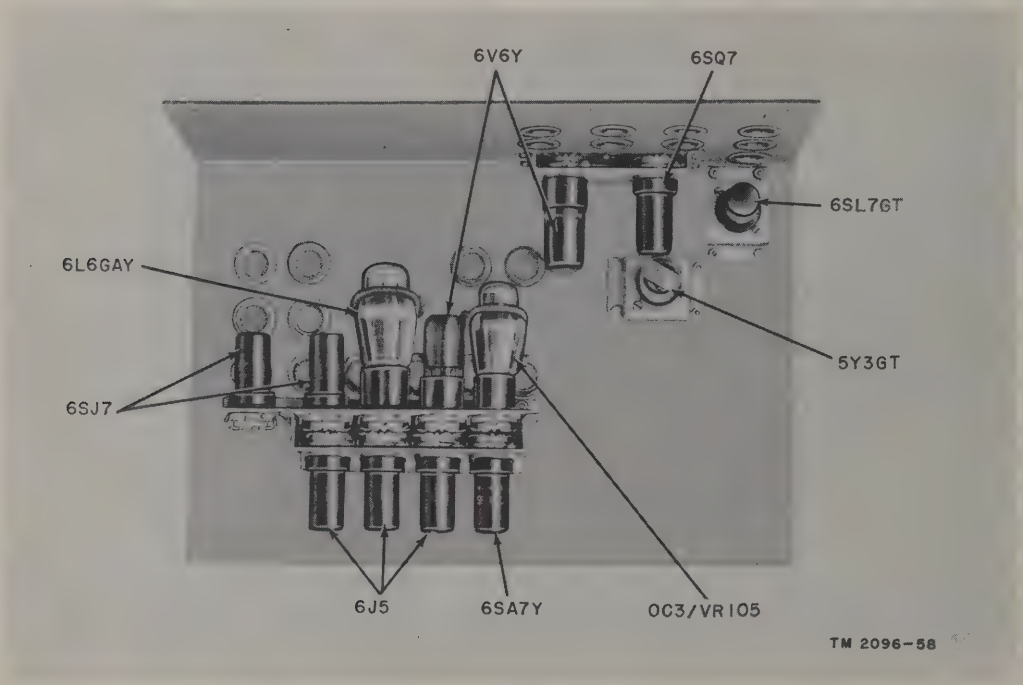

Figure 5. Signal Generator SG-15/PCM, spare tubes mounted inside top of cover.

CHAPTER 2

OPERATING INSTRUCTIONS FOR SIGNAL GENERATOR SG-15/PCM

Section I. SERVICE UPON RECEIPT OF MATERIEL

8. Siting Equipment

No special instructions are necessary for siting Signal Generator SG-15/PCM. A suitable source of 115- or 230-volt, 50- to 70-cycle ac must be available. A water-pipe ground or a comparable ground connection near the operating location also will be required.

9. Uncrating, Unpacking, and Checking New Equipment

a. GENERAL. Signal Generator SG-15/PCM may be packaged for oversea or domestic shipment (par. 5). When new equipment is received, select a location where it may be unpacked without exposure to dust, dirt, or excessive moisture. Be careful when uncrating and unpacking the equipment. Avoid thrusting tools into the interior of the wooden box. When unpacking, do not damage the packaging materials any more than is necessary. These materials may be used when repacking the equipment for storage or for shipment to base maintenance repair shops. Store the interior packaging materials carefully in the wooden shipping container. Be careful when handling the equipment—it may be damaged easily when it is not protected by the shipping container.

b. STEP-BY-STEP INSTRUCTIONS FOR UNPACKING EQUIPMENT PACKED FOR DOMESTIC SHIPMENT. (1) Cut the seals of the corrugated fiberboard box.

(2) Remove the equipment from the box.

(3) Check the equipment against the shipping documents.

(4) Thoroughly inspect the equipment for possible damage during shipment.

(5) Save the corrugated box for use in repacking the equipment.

c. STEP-BY-STEP INSTRUCTIONS FOR UNCRATING AND UNPACKING EQUIPMENT PACKED FOR OVERSEA SHIPMENT. (1) Cut the metal straps with a suitable cutting tool or twist them with pliers until the straps break.

(2) Remove the nails from the top of the wooden box with a nail puller. Remove the top of the box.

(3) Remove the excelsior which covers the packaged signal generator. If the signal generator is shipped as a unit the spare tubes are packed in a second fiberboard box. Remove the excelsior covering this box. When the signal generator is shipped as a part of Test Set TS-140/PCM, the spare tubes are packaged with those of the decibel meter and packed in the wooden box containing the decibel meter (see Instruction Book for Decibel Meter ME-22/PCM).

Note. Unpacking instructions in subparagraphs (4) through (8) below, apply to the package containing the spare tubes as well as to the package containing the signal generator.

(4) Cut the adhesive tape that seals the waterproof barrier of the packaged equipment. Be careful not to damage the waterproof barrier material.

(5) Remove the contents of the waterproof barrier.

(6) Cut the seals of the corrugated fiberboard box and remove the boxed equipment which is wrapped in a moisture-vaporproof barrier.

(7) Cut the adhesive tape that seals the moisture-vaporproof barrier and remove the inner corrugated fiberboard box.

(8) Cut the seals of the inner corrugated fiberboard box and remove the equipment.

(9) Loosen the fastenings of the carrying case cover. Open the cover and remove the desiccant and the technical manual.

(10) Loosen the fastenings which secure the signal generator to the shock-mounted rack and remove the equipment from the carrying case.

(11) When the spare tubes are packaged separately or with the tubes of Decibel Meter ME-22/PCM, unpack the tubes and place them in their normal positions on the inside of the top of the cover.

(12) Place the cushioning material and the inner cartons in the outer shipping container for use in repacking the signal generator.

(13) Check the equipment against the shipping documents.

(14) Thoroughly inspect the equipment for possible damage during shipment.

10. Installation of Equipment

The signal generator is portable and may be set up in its carrying case near the equipment to be tested. When the nature of operation requires, the signal generator may be rack-mounted on a 19-inch rack by placing mounting screws in the slots provided at both ends of the front panel. Before operating the signal generator, connect an external ground to the GND terminal on the front panel. This terminal is a thumbscrew-type binding post with a wire slot in the neck for convenient ground connection. If available, a cold water pipe can be used for the ground connection. Connect the ground wire to the pipe with a suitable pipe clamp equipped with a soldering lug. Before connecting the clamp, thoroughly clean the pipe, where the connection is to be made, with emery cloth.

Caution: Never connect the ground wire to a pipe that is used as an electric power protection panel ground or to a conduit which protects electrical wiring.

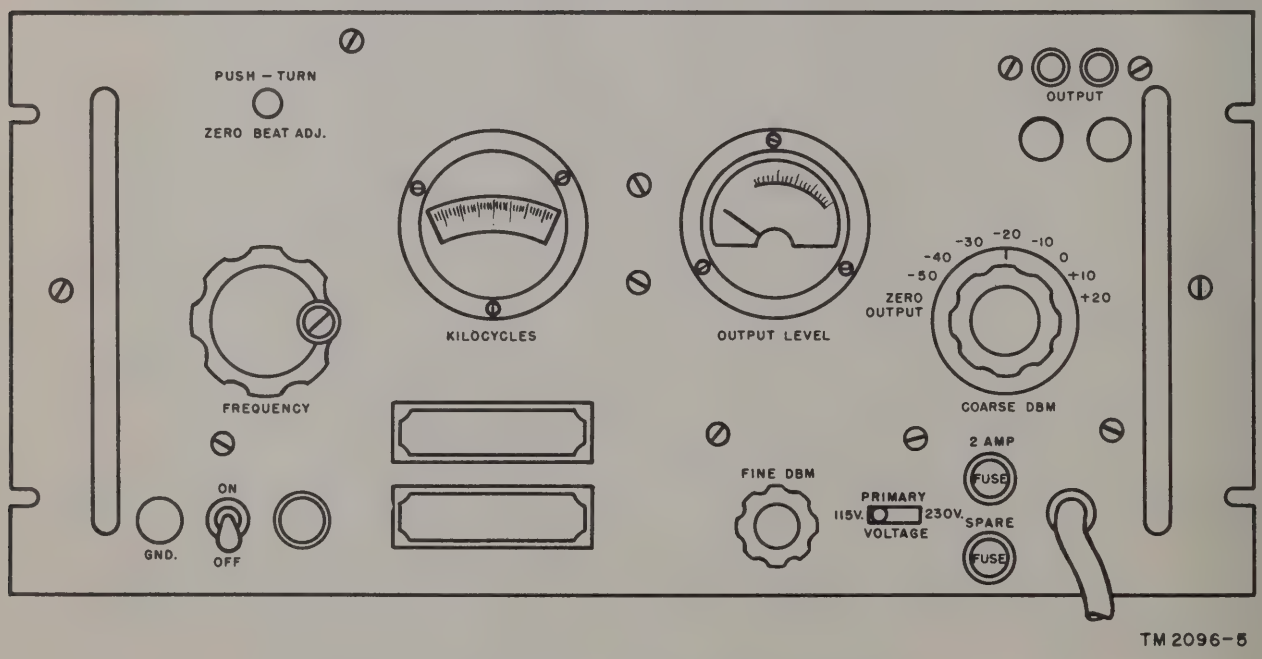

Figure 6. Signal Generator SG-15/PCM, front panel.

11. Service Upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions given in paragraph 9 for uncrating, unpacking, and checking the equipment.

b. Check the used or reconditioned signal generator against a new equipment, if available. Make sure that the wiring has not been changed and that no parts have been damaged. If the wiring has been changed, note the changes on the wiring diagram (fig. 30). Operate the equipment in accordance with the procedures outlined in the equipment performance checklist (par. 42) to make sure that it is operating properly.

Section II. CONTROLS, METER AND PANEL CONNECTIONS

12. Controls and Meter and Their Use

a. CONTROLS. The table below lists the controls of Signal Generator SG-15/PCM and gives the function of each. The location of these controls is shown in figure 6.

Control	Function
Power ON-OFF switch S2.	In ON position, connects primary of power transformer T3 to a-c source.
PRIMARY VOLTAGE switch S1.	In 115 V position, connects primary windings of power transformer T3 in parallel for operation with 115-volt a-c power source. In 230 V position, connects these windings in series for operation with 230-volt a-c power source.
Indicator light I-1 (to right of ON-OFF switch).	Lights when power is applied to signal generator.
FREQUENCY control C9.	Variable capacitor used to set signal generator to desired frequency by tuning the variable frequency oscillator.
ZERO BEAT ADJ control C1.	Variable capacitor used to adjust the frequency of the fixed frequency oscillator to obtain zero beat between this oscillator and the variable frequency oscillator.
KILOCYCLES dial.	Mechanically coupled to the FREQUENCY control, this dial indicates the output frequency of the signal generator. The dial is calibrated in equal graduations of 10 cps in the frequency range from 200 to 1,000 cps, 20 cps in the frequency range from 1,000 to 2,000 cps, and 50 cps in the frequency range from 2,000 to 35,000 cps.
FINE DBM potentiometer R11.	Variable attenuator which permits adjustment of the output from —4 db to +6 db above or below the setting of the COARSE DBM control.
COARSE DBM attenuator E4.	A stepped attenuator which provides selection of output ranges in eight steps: —50 dbm, —40 dbm, —30 dbm, —20 dbm, —10 dbm, 0 dbm, +10 dbm, and +20 dbm. A ninth step, ZERO OUTPUT, short-circuits the output terminals of the attenuator. The output power of the signal generator is the sum of the setting of this attenuator and the reading on the OUTPUT LEVEL meter.

b. METER. OUTPUT LEVEL meter M1 (fig. 6) is a d-c (direct-current) milliammeter calibrated in db with reference to 1 mw (milliwatt) and extends over a range of 10 db—from —4 through +6 db. The meter reading is determined by adjustment of FINE DBM control R11. With COARSE DBM attenuator E4 on the setting nearest the desired output, the meter reading indicates the difference between the output power of the signal generator and the setting of the COARSE DBM control.

13. Panel Connections

The table below lists the connecting facilities located on the front panel of the signal generator and gives the function of each. To locate these parts, refer to figure 6.

Connection	Function
OUTPUT TERMINALS E1 and E2.	Thumbscrew-type binding posts for connecting the output of the signal generator to equipment to be tested through wire leads.
OUTPUT jack J1.	Twin jack connected in parallel with terminals E1 and E2. For connecting output of signal generator to equipment to be tested through switchboard patching cords provided with the signal generator.
GND terminal E3.	Thumbscrew-type binding post. For connecting chassis of signal generator to external ground.
Power cable assembly W1.	For connecting signal generator to source of 115- or 230-volt, 50- to 70-cycle ac.

Section III. OPERATION OF SIGNAL GENERATOR SG-15/PCM UNDER USUAL CONDITIONS

14. Preliminary Starting Procedures

a. Determine whether the power source to be used is 115- or 230-volt ac.

b. Set the toggle switches on the front panel in the following positions:

Switch	Position
Power ON-OFF switch S2.	OFF.
PRIMARY VOLTAGE switch S1.	In the 115 V position if a 115-volt power source is to be used. In the 230 V position if a 230-volt power source is to be used.

c. Connect the power cable to an a-c outlet.

Note. Be sure that GND terminal E3 is connected to an external ground before operation of the equipment (par. 10).

15. Starting Procedures

a. Set the FREQUENCY control to the minimum frequency of 200 cps (cycles per second) as determined by the reading of the KILOCYCLES dial.

b. Set the FINE DBM control to midposition.

c. Set the COARSE DBM control to ZERO OUTPUT.

d. Set the power ON-OFF switch to ON. Allow the equipment to warm up for 10 to 15 minutes before proceeding.

16. Calibration of Signal Generator SG-15/PCM

a. Set the FINE DBM control for a reading of approximately +6 on the OUTPUT LEVEL meter.

b. Set the FREQUENCY control to 0 as indicated on the KILOCYCLES dial.

c. Adjust the ZERO BEAT ADJ control for zero beat as indicated by zero deflections on the OUTPUT LEVEL meter. The meter indicator will deflect a number of times per second, decreasing in frequency as adjustment is made until there is no deflection at zero beat.

Note. As the FREQUENCY control is varied above and below 0 on the KILOCYCLES dial, note that the *zero beat region* is about ⅛ inch wide. Set the ZERO BEAT ADJ control so that zero frequency is in the center of this region.

17. Operation

a. Set the FREQUENCY control to the desired frequency as read on the KILOCYCLES dial.

b. Set the COARSE DBM control to the attenuation setting nearest to the desired output.

c. Set the FINE DBM control for a reading on the OUTPUT LEVEL meter which, when added to the setting of the COARSE DBM control, gives the desired output. For example, if an output of —18 dbm is required, set the COARSE DBM control to —20 and the FINE DBM control for a reading of +2 on the OUTPUT LEVEL meter; the algebraic sum of —20 dbm and +2 dbm is —18 dbm. If an output of —22 dbm is required, set the COARSE DBM control to —20 and the FINE DBM control for a reading of —2 on the OUTPUT LEVEL meter; the algebraic sum of —20 dbm and —2 dbm equals —22 dbm.

d. Connect the output of the signal generator to the input of the equipment to be tested. Note that the dbm calibration of the signal generator holds only when the output is applied to equipment which has an input impedance of 600 ohms (par. 3).

e. If it is necessary to disconnect the output of the signal generator from the equipment being tested and later apply the signal again, do not turn off the signal generator. Set the COARSE DBM control to ZERO OUTPUT or disconnect the leads. When the signal is required again, set the COARSE DBM control to the proper attenuation setting. Turning off the equipment would entail another warm-up period and recalibration of the ZERO BEAT ADJ control.

18. Stopping Procedure

a. Set the power ON-OFF switch to OFF.

b. Disconnect the output leads from the OUTPUT terminals, or remove the switchboard patching cord from the OUTPUT jack.

c. Disconnect the power cable from the a-c power source.

d. If the equipment is to be moved to a new location, disconnect the ground lead from the GND terminal and return the signal generator to its carrying case.

Section IV. OPERATION OF SIGNAL GENERATOR SG-15/PCM UNDER UNUSUAL CONDITIONS

19. General

When operating Signal Generator SG-15/PCM in regions where extreme cold, heat, humidity, moisture, and sand conditions prevail, special precautions must be taken to keep the equipment in operating condition at all times. Paragraphs 20 through 22 give instructions for minimizing the effect of these unusual operating conditions.

20 Operation in Arctic Climates

Since Signal Generator SG-15/PCM is intended for indoor use, it will be exposed to extreme cold only when in storage or in transport. When possible, house and use the equipment in a heated shelter. If the test set has been exposed to the cold, it will sweat until it reaches room temperature. This condition also arises when the equipment warms up during the day after exposure during a cold night. When the test set has reached room temperature, dry it thoroughly before attempting to operate the unit. Perform preventive maintenance operations (par. 33) frequently to keep the unit as moisture-free as possible.

21. Operation in Desert Climates

The main problem when operating the signal generator in desert climates is to prevent dirt, dust, and sand from filtering into the equipment. If possible, house and use the equipment

in a dustproof shelter. Since such a building is seldom available, however, make the shelter as dust-free as possible by hanging wet sacking over windows and doors, covering the inside walls with heavy paper, and preventing the side walls of tents from flapping in the wind by securing them with sand. Be sure that the cover and bottom plate of the equipment are in place at all times. Close and latch the lid of the signal generator case when the unit is not in use and cover it with canvas or other material.

22. Operation in Tropical Climates

When operated in tropical climates, the signal generator should be used in a building or shelter. The high relative humidity of such climates causes condensation of moisture on the equipment whenever the temperature of the equipment becomes lower than the ambient air. Inspect and clean the equipment frequently to keep it free from rust, corrosion, and fungus growth. Keep the equipment as dry as possible.

CHAPTER 3

OPERATING INSTRUCTIONS FOR TEST SET TS-140/PCM

Section I. GENERAL

23. Purpose and Use

Test Set TS-140/PCM (fig. 7) consists of Signal Generator SG-15/PCM and Decibel Meter ME-22/PCM in Carrying Cases CY-712/PCM and CY-711/PCM, respectively. This test set is designed for making transmission measurements of carrier equipment and wire and cable lines where portable apparatus is required, to provide a source of testing power, and to measure received testing power. The signal generator provides an output of —54 to +26 dbm over a frequency range of 200 cycles to 35 kc. It has an output impedance of 600 ohms. The decibel meter is capable of measuring received power from —45 to +25 dbm over the same frequency range and is arranged for an input impedance of 600 or 8,000 ohms. The test set operates from 115- or 230-volt, 50- to 60-cycle ac. Paragraphs 25 through 28 give detailed instructions for the operation of the test set.

24. Controls, Meters, and Panel Connections of Test Set TS-140/PCM

a. SIGNAL GENERATOR SG-15/PCM. The controls, meter, and connecting facilities for external connections, located on the front panel of Signal Generator SG-15/PCM, and the function of each are given in paragraphs 12 and 13.

b. DECIBEL METER ME-22/PCM. (1) *Controls.* The following table lists the controls of Decibel Meter ME-22/PCM and gives the function of each control:

Control	Function
Power ON-OFF switch S4.	In the ON position, connects primary of power transformer T2 to a-c source.
PRIMARY VOLTAGE switch S3.	In the 115 position, connects primary windings of power transformer T2 in parallel for operation with a 115-volt a-c source. In the 230 position, connects these windings in series for operation with a 230-volt a-c source.
Indicator light I-1.	Lights when power is applied to decibel meter.
INPUT IMPEDANCE switch S1.	In the 600 OHM position, connects input transformer T1 for 600-ohm input impedance. In the BRIDGING position, connects input transformer T1 for 8,000-ohm input impedance.
CAL ADJ potentiometer R10.	Adjusts zero level of meter M1.
DBM switch S2.	Selects attenuation setting required for use of meter M1 with any given signal. Switch provides six steps in two scales as follows: SCALE A, 0 dbm and +10 dbm; SCALE B, —30 dbm, —20 dbm, —10 dbm, and 0 dbm.

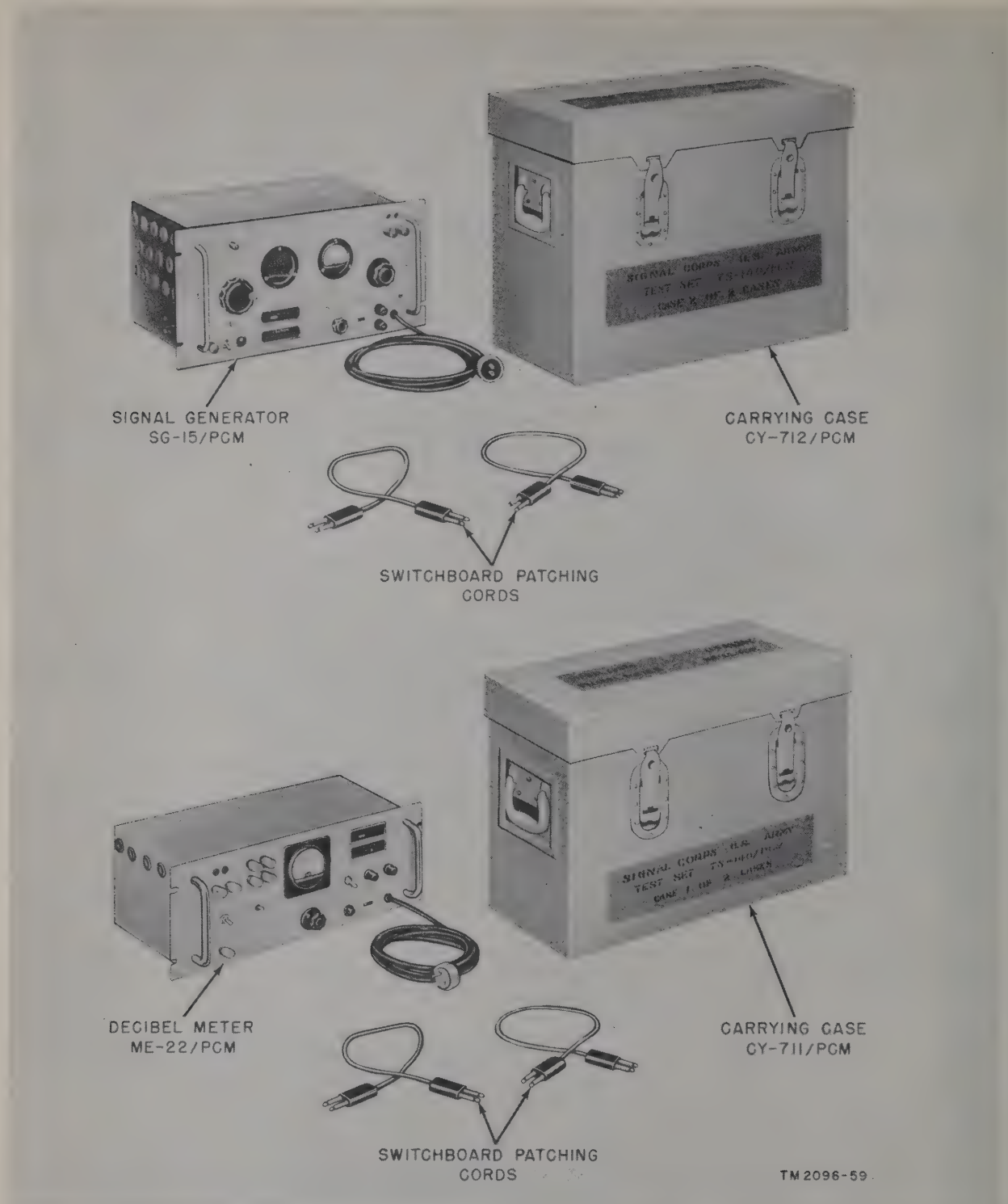

Figure 7. Test Set TS-140/PCM, components.

(2) *Meter.* Meter M1 is an output meter calibrated in two scales as follows: SCALE A, 0 db to +15 db; SCALE B, —15 db to 0 db. The reading of Decibel Meter ME-22/PCM is the sum of the reading of meter M1 on either scale, and the setting of DBM switch S2 on the corresponding scale.

(3) *Panel connections.* The following table lists the connecting facilities located on the front panel of Decibel Meter ME-22/PCM and gives the function of each.

Connection	Function
INPUT terminals E1 and E2.	For connecting output of equipment being tested to input of decibel meter.
INPUT jack J1.	Connected in parallel with INPUT terminals. Used as alternate method of connecting signal to decibel meter.
TERMINATING RESISTORS — 600 OHMS terminals E3 and E4, and 475 OHMS terminals E5 and E6.	A 600-ohm, 2-watt resistor is connected across the terminals designated 600 OHMS, and a 475-ohm, 2-watt resistor is connected across the terminals designated 475 OHMS. These resistors are used, when required, as terminating resistors for external equipment.
GND terminal E7.	For connecting chassis of decibel meter to external ground.
Power cable assembly W1.	For connecting decibel meter to source of power.

Section II. GAIN AND LOSS MEASUREMENTS

25. General

a. Gain may be defined as the ratio of the output power of any equipment to the input power. When this ratio represents an increase in power, it is referred to as *gain.* When it represents a decrease, it is referred to as *loss.*

b. Gain and loss may be measured directly with Test Set TS-140/PCM since the front panel controls and meters of both the signal generator and the decibel meter indicate power levels in dbm.

26. Preliminary Starting Procedures

a. GENERAL. Determine whether the power source to be used is 115- or 230-volt ac.

b. SIGNAL GENERATOR SG-15/PCM. (1) Set the power ON-OFF switch to the OFF position.

(2) Set the PRIMARY VOLTAGE switch to the 115V position if a 115-volt line is to be used. Set the switch to the 230V position if a 230-volt line is to be used.

(3) Make a ground connection to the GND terminal.

(4) Connect the power cable to the a-c power source.

c. DECIBEL METER ME-22/PCM. (1) Set the power ON-OFF switch to the OFF position.

(2) Set the PRIMARY VOLTAGE switch to the 115 position if a 115-volt line is to be used. Set it to the 230 position if a 230-volt line is to be used.

(3) Connect the GND terminal to ground.

(4) Connect the power cable to the a-c power source.

27. Starting Procedures

a. SIGNAL GENERATOR SG-15/PCM. (1) Set the FREQUENCY control to minimum frequency as read on the KILOCYCLES dial.

(2) Set the FINE DBM control to midposition.

(3) Set the COARSE DBM control to the ZERO OUTPUT position.

(4) Set the power ON-OFF switch to ON and allow the unit to warm up for 10 to 15 minutes before proceeding with adjustments.

b. DECIBEL METER ME-22/PCM. Set the power ON-OFF switch to ON and allow the equipment to warm up for 5 to 10 minutes.

c. SIGNAL GENERATOR SG-15/PCM AFTER WARM-UP. When the signal generator has warmed up sufficiently, make the following adjustments:

(1) Set the FINE DBM control for a reading of approximately +6 on the OUTPUT LEVEL meter.

(2) Set the FREQUENCY control to 0 as indicated on the KILOCYCLES dial.

(3) Adjust the ZERO BEAT ADJ control for zero beat as indicated by zero deflections on the OUTPUT LEVEL meter. The meter indicator deflects a number of times per second, decreasing in frequency as adjustment is made until there is no deflection at zero beat. As the FREQUENCY control is varied above and below 0 on the KILOCYCLES dial, note that the *zero beat region* is about ⅛ inch wide. Set the ZERO BEAT ADJ control so that zero frequency is in the center of this region.

(4) Set the FREQUENCY control for an output frequency of 1,000 cycles as read on the KILOCYCLES dial.

(5) Set the COARSE DBM control to 0 and set the FINE DBM control for a reading of 0 dbm on the OUTPUT LEVEL meter.

d. DECIBEL METER ME-22/PCM AFTER WARM-UP. When the warm-up period of the decibel meter has been completed, proceed as follows:

(1) Set the DBM switch to 0 on SCALE B.

(2) Set the INPUT IMPEDANCE switch to the 600 OHM position.

e. FINAL ADJUSTMENT. (1) Use one of the switchboard patching cords provided with Test Set TS-140/PCM to connect the OUTPUT jack of the signal generator to the INPUT jack of the decibel meter.

(2) On the decibel meter, adjust the CAL ADJ potentiometer until the meter reads exactly 0 db on SCALE B. Then set the DBM switch to 0 on SCALE A. The meter still should read 0 db ±.5 db.

(3) Disconnect the signal generator from the decibel meter by disconnecting the switchboard patching cord from the OUTPUT jack of the signal generator.

28. Gain or Loss Measurements

When the test set has been calibrated in accordance with instructions in paragraphs 26 and 27, proceed with gain or loss measurements (subpars. *a* through *g* below). The circuit under measurement must have an impedance of approximately 600 ohms at the points of connection to the signal generator and the decibel meter. This requirement must be met whether the circuit is terminated or bridged by the connection to the test equipment.

a. Connect the OUTPUT jack or terminals of the signal generator to the input of the circuit to be measured.

b. Set the INPUT IMPEDANCE switch of the decibel meter to 600 OHM, and connect the INPUT jack or terminals to the output of the circuit to be measured. If the measurement is to be made at a bridging point, however, set the INPUT IMPEDANCE switch to BRIDGING and connect the INPUT of the decibel meter to the bridging point of the circuit to be measured.

c. Set the FREQUENCY dial of the signal generator to the appropriate test frequency. Adjust the output power (dbm) as required for proper circuit performance.

d. Adjust the DBM range switch of the decibel meter to obtain a reading on the meter scale.

e. Read the output signal power of the signal generator in dbm by algebraically adding the setting of the COARSE DBM control to the reading of the OUTPUT LEVEL meter. For example, if the COARSE DBM control is set

at —20 and the OUTPUT LEVEL meter reads +3, the output signal power in dbm equals —20 +3, or —17 dbm.

f. Read the power, in dbm, of the test signal received at the INPUT jack or terminals of the decibel meter by algebraically adding the meter reading on SCALE A or B and the setting of the DBM range switch on its corresponding SCALE A or B. To do this, substitute the meter scale reading on SCALE A or B for the scale letter, A or B, on which the DBM range switch is set. For example, if the DBM range switch setting is —20 on SCALE (B-20) and the meter SCALE B reading is —7, the received power in dbm equals B-20 or (—7)—20, or —27 dbm.

g. Compute the gain or loss in db of the circuit being measured by subtracting the test signal power in dbm (subpar. *e* above) from the received signal power in dbm (subpar. *f* above). For example, if the test signal power applied to a circuit is —17 dbm and the received signal power is —27 dbm, the difference between the applied and received signals equals —27 — (—17) or —27 +17, or —10 db. The negative sign of the difference denotes loss, and the quantity is expressed as a loss of 10 db. A positive sign denotes gain.

Note. For the theory of operation, maintenance, and trouble-shooting procedures pertaining to Decibel Meter ME-22/PCM, refer to the instruction book covering the decibel meter.

CHAPTER 4

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. ORGANIZATIONAL TOOLS AND MATERIALS

29. General

Before starting preventive maintenance procedures, have available all tools and materials needed to perform the operations listed in the preventive maintenance checklist (par. 33). These tools and materials may be obtained through regular supply channels.

30. Tools and Materials

Tools and materials for organizational maintenance operations are listed below:

Signal Corps stock No.	Name of item and description	Used to
6Z7500-0000	ABRASIVE, sheet: sandpaper; #0000; 9″ x 12″ sheets.	Remove rust and corrosion from metal parts.
CE supply No. 38-3706.300.200	BRUSH, paint: soft hair; flat; 1″ wide.	Remove dust, dirt, and lint from switches and controls and from interior of equipment.
6G184.1	CARBON TETRACHLORIDE.	Remove gummy deposits from jack contacts.
6Z1989	CLOTH, textile: cheesecloth; lint-free; 36″ wide.	Clean various parts of equipment.
QM supply No. 51-S-4385-1	SOLVENT, Dry Cleaning (SD).	Clean grease, oil, and corrosion from equipment.
6Z7360	STICK: orange.	Remove fungus growth from apparatus.
6N8583	TAPE TL-83: friction; ¾″ wide.	Repair wiring insulation.

Caution: Repeated contact of carbon tetrachloride with the skin or prolonged breathing of the fumes is dangerous. Make sure adequate ventilation is provided.

Section II. PREVENTIVE MAINTENANCE SERVICES

31. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment, usually when the equipment is not in use, to keep it in such good working order that break-downs and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from trouble shooting and repair since its object is to prevent certain troubles from occurring. See AR 750-5 for information on organizational, field, and base maintenance.

32. General Preventive Maintenance Techniques

a. Use #0000 sandpaper to remove corrosion.

b. Use a clean, dry, lint-free cloth or a dry brush for cleaning.

(1) If necessary, except for electrical contacts, moisten or brush with solvent (SD) and then wipe the parts with a cloth.

(2) Clean electrical contacts with a cloth moistened with carbon tetrachloride and wipe them dry with a dry cloth.

c. If available, dry compressed air may be used at a line pressure not exceeding 60 psi (pounds per square inch) to remove dust from inaccessible places. Be careful, however, or mechanical damage from the air blast may result.

33. Performing Preventive Maintenance

The following checklist shows the operator how to maintain the equipment so that trouble shooting and repair can be reduced to a minimum. The list shows what, when, and how to check, and precautions to be taken before, during, and after checking the equipment. The operations are self-explanatory.

Item No.	What to check	When to Check[a]	How to check	Precautions
1	Exterior of signal generator.	W	Inspect for damaged places, chipped paint, dirt, dust, grease, rust, corrosion, broken or loose control knobs, and loose or missing screws. Tighten all loose screws and replace any screws that are missing. Tighten the setscrews on the sides of the FREQUENCY, FINE DBM, and COARSE DBM control knobs. Wipe off dirt and grease with a clean, dry cloth. Use a cloth slightly moistened with solvent (SD) to remove dirt, oil, or corrosion which cannot be removed with a dry cloth. Loosen rust or corrosion which cannot be removed with solvent (SD) with #0000 sandpaper and wipe with a cloth moistened with the cleaning fluid. Wipe dry with a dry cloth.	Do not tighten screws carelessly. Screws tightened beyond the pressure for which they are designed will be damaged or broken.
2	Back of front panel and interior of case.	M	Remove the top rear cover and bottom plate by removing the screws holding these parts in place. Inspect the back of the front panel for dust, dirt, fungus growth, corrosion, loose or missing screws, loose connections at apparatus terminals, broken leads, and defective insulation. Tighten any loose mounting screws and nuts with a suitable screw driver and wrench. Tape leads having defective insulation. Wipe out the interior of the case with a dry cloth and remove dirt adhering to the case with a cloth dampened with solvent (SD). Clean dirt and dust from the apparatus and wiring with a sash brush or some other soft bristle brush. Wipe accessible parts with a clean, dry cloth. If fungus growth is present, be sure that the equipment is thoroughly dry before brushing it off. Remove heavy fungus growth with an orange stick and wipe the apparatus with a clean cloth moistened with solvent (SD). Loosen corrosion that cannot be removed with solvent (SD) and #0000 sandpaper. Inspect all filter capacitors for leakage or oil, and dielectric capacitors for bulging and for overheating. Inspect power transformer T3 and filter choke L3 for excessive heating. Inspect all resistors for blistering, discoloration, and other evidence of overheating.	Disconnect all power before performing preventive maintenance operations. Upon completion of these operations, reconnect the power and check the equipment for satisfactory operation. Tighten screws and nuts securely, but do not overtighten. Be careful not to break connections or damage wiring. Do not get solvent (SD) on switch or jack contacts or on insulators. Never use a damp or wet cloth to clean wiring. Do not open the oscillator assembly and do not disturb the trimmer settings.

33. Performing Preventive Maintenance (contd)

Item No.	What to check	When to Check[a]	How to check	Precautions
3	Switches, controls, and jacks.	S	Inspect the mechanical action of the power ON-OFF, PRIMARY VOLTAGE, and COARSE DBM switches by operating each switch several times. Note that the contacts close with a slight follow when the switch is operated. Inspect the mechanical action of the ZERO BEAT ADJ and FREQUENCY controls and the FINE DBM potentiometer on the front panel by operating the potentiometer and each control through its range several times. Note that the shafts neither bind nor are excessively loose. Inspect the mechanical action of OUTPUT jack J1 by inserting a plug into the jack. Inspect for dirt and corrosion on all exposed elements and examine the contacts for dirt, pits, and build-ups. Tighten loose assembly screws with a suitable screw driver.	Disconnect all power before performing preventive maintenance operations. When these operations have been completed, reconnect the power and check the equipment for satisfactory operation. Do not overtighten screws. Do not disturb permanent settings of adjustable apparatus mounted on the chassis.

[a] W — Weekly; M — Monthly; S — Semiannually.

Section III. WEATHERPROOFING

34. General

Signal Corps equipment, when operated under severe climatic conditions such as prevail in tropical, arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

35. Tropical Maintenance

A special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. This treatment is explained fully in TB SIG 13 and TB SIG 72.

36. Winter Maintenance

Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperature are explained fully in TB SIG 66 and TB SIG 219.

37. Desert Maintenance

Special precautions necessary to prevent equipment failure in areas subject to extremely high temperature, low humidity, and excessive sand and dust are explained fully in TB SIG 75.

38. Rustproofing and Painting

When painted finishes have been marred or damaged, prevent rust and corrosion by touching up bared surfaces as follows:

a. Use #0000 sandpaper to clean the surface down to the bare metal. Obtain a bright, smooth finish.

Caution: Do not use steel wool to remove rust. Minute particles of metal may fall into the equipment and cause shorting or grounding of circuits.

b. Remove rust by cleaning corroded metal with solvent (SD). In severe cases, it may be necessary to use solvent (SD) to soften the rust and sandpaper to complete the preparation for painting.

c. For a touch-up job, use a small brush to apply paint to the bared surfaces. Use authorized paint, consistent with existing regulations. Apply one coat of clear lacquer to parts having a bright metal finish. When a complete refinishing job is necessary, refer to instructions in paragraph 86.

Section IV. TROUBLE SHOOTING AT ORGANIZATIONAL MAINTENANCE LEVELS

39. Scope

The trouble shooting and repair work that can be performed at the organizational maintenance level (operators and repairmen) is limited in scope by the tools, test equipment, and replaceable parts issued and by the existing tactical situation. With the exception of replacing operated fuses, faulty indicator lamps, and defective vacuum tubes, trouble shooting by the operator is based on the performance of the equipment and is merely a general identification of the trouble and a recommendation that the trouble be repaired by qualified repair personnel.

40. Visual Inspection

a. When the signal generator fails to operate properly, inspect the equipment for the following faults:

(1) Power cord for improper connection.

(2) Cords and plugs for wear, breaks, and disconnection.

(3) Wiring for loose or poorly soldered connections, frayed or burned insulation, stretched leads, or breaks caused by excessive vibration.

(4) Terminal boards for broken lugs and signs of arcing.

(5) Fuses for corrosion or burn-out.

(6) Resistors and power transformer for overheating and burn-out.

(7) Vacuum tubes for defects.

(8) Jacks and switches for dirty or broken contacts.

b. When equipment fails and the cause is not immediately apparent, check as many of the above items as is practicable before starting a detailed examination of the component parts of the equipment. If possible, obtain information from the operator of the equipment regarding performance at the time the trouble occurred.

41. Trouble Shooting (Using Equipment Performance Checklist)

a. GENERAL. The equipment performance checklist (par. 42) will help to locate trouble in the equipment. The list gives the items to be checked, the normal indications and tolerances of correct operation, and the corrective measures that can be taken by the operator. To use this list, follow the items in numerical sequence.

b. ACTION OR CONDITION. For some items, the information given in the *Action or condition* column consists of various switch and control settings under which the item is to be checked. For other items it represents an action that must be taken to check the normal indication given in the *Normal indication* column.

c. NORMAL INDICATIONS. The normal indications listed include the visible and audible signs that the operator should perceive when he checks the items. If the indications are not normal, the operator should apply the recommended corrective measures.

d. CORRECTIVE MEASURES. The corrective measures listed are those which the operator can make without turning in the equipment for repair. A reference in the table to paragraphs in chapter 6 indicates that trouble shooting by an experienced repairman is necessary. If the set is completely inoperative or if the recommended corrective measures do not yield results, trouble shooting is necessary. However, if the tactical situation requires that operation be maintained, and if the set is not completely inoperative, the operator must keep the set in operation as long as it is possible to do so.

42. Equipment Performance Checklist for Signal Generator SG-15/PCM

	Item No.	Item	Action or condition	Normal indication	Corrective measure
PREPARATORY	1	Power ON-OFF switch.	Set to OFF position.		
	2	GND terminal.	Connect to water pipe or to comparable external ground.		
	3	Power source of 115- or 230-volt, 50- to 70-cycle ac.	Check to determine voltage.		
	4	PRIMARY VOLTAGE switch.	Set to position which corresponds to voltage of power source, 115 V or 230 V.		
	5	Power cable.	Connect to power source.		
START	6	FREQUENCY control.	Set to minimum position.	KILOCYCLES dial reads minimum frequency (200 cps).	
	7	ZERO BEAT ADJ control.	Adjust for zero beat on OUTPUT LEVEL meter.	OUTPUT LEVEL meter indicator deflects a number of times per second. As control is adjusted, number of deflections decreases to zero.	See paragraph 74*a* (1) through (3).
	8	FINE DBM control.	Set to midposition.		
	9	COARSE DBM control.	Set to ZERO OUTPUT position.		
	10	Power ON-OFF switch.	Set to ON position. Allow 10- to 15-minute warm-up period.	Pilot lamp lights.	Check power source; be sure that setting of PRIMARY VOLTAGE switch corresponds to voltage. Check power cord and connectors; repair or replace if necessary. Check fuse and pilot lamp; replace fuse and pilot lamp if defective.
	11	FINE DBM control.	Set to obtain reading of approximately +6 on OUTPUT LEVEL meter.		
EQUIP PERF	12	OUTPUT jack or terminals.	Connect to equipment under test.		
	13	ZERO BEAT ADJ control.	Adjust for zero beat on OUTPUT LEVEL meter.	OUTPUT LEVEL meter indicator deflects a number of times per second. As control is adjusted, number of deflections decreases to zero.	See paragraph 74*a* (1) through (3).

42. Equipment Performance Checklist for Signal Generator SG-15/PCM (contd)

	Item No.	Item	Action or condition	Normal indication	Corrective measure
EQUIPMENT PERFORMANCE	14	FREQUENCY control.	Set to desired frequency.	Frequency indicated on KILOCYCLES dial.	See paragraph 76.
	15	COARSE DBM control.	Set COARSE DBM control to attenuation setting (—50 to +20) nearest desired output.	Reading on OUTPUT LEVEL meter should not change (with a 600-ohm load only).	Check power output of signal generator with Decibel Meter ME-22/PCM or measure with Electronic Multimeter ME-6/U with a 600-ohm resistor across the input of the multimeter. If the output is within limits, check and adjust the metering circuit (par. 78.)
	16	FINE DBM control.	Set for desired reading on OUTPUT LEVEL meter. Reading of meter plus setting of COARSE DBM control equals output power of signal generator.	If desired reading on the OUTPUT LEVEL meter is at either end of the meter range (—4 or +6 db), the adjustment of the FINE DBM control made to obtain this reading should not be at either limit of the control.	See paragraph 78.
STOP	17	OUTPUT jack or terminals.	Disconnect from equipment under test.		
	18	Power ON-OFF switch.	Turn to OFF position.	Pilot lamp goes out.	
	19	Power cable.	Disconnect from power source.		
	20	GND terminal.	Disconnect from external ground if equipment is to be moved to new location.		

CHAPTER 5

THEORY

Section I. THEORY OF SIGNAL GENERATOR SG-15/PCM

43. General

Signal Generator SG-15/PCM is a heterodyne-type vacuum-tube oscillator which provides a source of testing power for transmission measurements of carrier equipment and wire and cable lines. The signal generator is capable of supplying an output of from —54 to +26 dbm to a 600-ohm load over a frequency range from 200 cycles through 35 kc. It has an output impedance of 600 ohms, and operates from a power source of 115- or 230-volt, 50- to 70-cycle ac. A special dial, which is geared to the oscillator frequency control, indicates the output frequency. An audio level meter, calibrated in db, indicates the output power when read in conjunction with the output attenuator setting. The following paragraphs contain a detailed discussion of the functioning of the stages and circuits which comprise this equipment.

44. Block Diagram

The general functioning of the various stages of Signal Generator SG-15/PCM, shown in the block diagram (fig. 8), is explained in subparagraphs *a* through *h* below. For a detailed analysis of the circuits and stages of the signal generator, refer to paragraphs 45 through 52.

a. Fixed Frequency Oscillator Stage. The fixed frequency oscillator stage consists of tube V1, a 6J5 triode connected as a tuned-grid cathode-coupled oscillator. The fixed frequency oscillator produces a constant output at approximately 100 kc ±2 kc. The exact frequency of the oscillator at zero beat, measured at 68° F, is stamped on the oscillator assembly housing. Oscillations generated by the fixed frequency oscillator circuit are fed to the grid circuit of 1st amplifier tube V7, a 6SJ7 pentode.

b. Variable Frequency Oscillator Stage. Like the fixed frequency oscillator, the variable frequency oscillator stage consists of tube V2, a 6J5 triode connected as a tuned-grid cathode-coupled oscillator. The variable frequency oscillator produces an output variable from approximately 100 kc to approximately 135 kc, depending on the setting of the FREQUENCY control. The setting of the FREQUENCY control is indicated by the reading on the KILOCYCLES dial, which is mechanically geared to the FREQUENCY control and indicates the output frequency of the signal generator. Oscillations generated by the variable frequency oscillator circuit, as determined by the setting of the FREQUENCY control, are fed to the control grid of 2d amplifier tube V8, a 6SJ7 pentode.

c. 1st Amplifier Stage. The 1st amplifier stage, which consists of tube V7, a 6SJ7 pentode, amplifies the signal applied by the fixed frequency oscillator. Tube V7 is self-biased by cathode resistor R29. The output of tube V7, developed across the primary of transformer T1 and induced into the secondary of this transformer, is applied to control grid 1 of mixer tube V9, a 6SA7Y pentagrid converter.

d. 2d Amplifier Stage. The 2d amplifier stage, which consists of tube V8, a 6SJ7 pentode, amplifies the signal applied by the variable frequency oscillator. Tube V8 is self-

biased by cathode resistor R31, and the output is developed across plate load resistor R33. The output of tube V8 is applied to control grid 3 of mixer tube V9.

e. MIXER STAGE. The mixer stage consists of tube V9, a pentagrid converter having two control grids, 1 and 3. The amplified 100-kc signal from the 1st amplifier is applied to control grid 1; the signal from the 2d amplifier, which depends on the setting of the FREQUENCY control, is applied to control grid 3. The signals are mixed in the tube, thus producing a beat frequency—the difference between the two applied signal frequencies—as well as other undesired frequencies. The output of the plate circuit of mixer tube V9 is applied to filter Z1, which has a 40-kc cutoff.

f. FILTER STAGE. The filter stage consists of filter Z1, a 0- to 40-kc filter, which is an inductance-capacitance network presenting a low-impedance path to beat frequencies in the 0- to 40-kc band and a high-impedance path to undesired frequencies present in the output of mixer tube V9. Fine tuning is accomplished by FINE DBM potentiometer R11, thus permitting control of the amplitude of the signal. The output of filter Z1 is applied to the grid of 3d amplifier tube V3, a 6J5 triode amplifier.

g. 3D AMPLIFIER STAGE. The 3d amplifier stage consists of tube V3, a 6J5 triode amplifier. The 3d amplifier receives the signal applied by filter Z1 through FINE DBM potentiometer R11, amplifies it, and applies it to the grid of 4th amplifier tube V4A, a 6SL7GT twin triode.

h. 4TH AMPLIFIER STAGE AND PHASE INVERTER. The 4th amplifier stage consists of one-half of tube V4, designated V4A, a 6SL7GT twin triode. The 4th amplifier receives the signal applied by the output of 3d amplifier tube V3, further amplifies it, and applies the amplified signal to the grid of phase inverter V4B, the second half of the twin triode tube V4, and to the control grid of power amplifier tube V5. Phase inverter tube V4B produces a signal which is equal in amplitude and opposite in phase to the signal of tube V4A and applies it to the control grid of power amplifier tube V6.

i. POWER AMPLIFIER STAGE. Power amplifier tubes V5 and V6 are 6V6Y beam-power tubes connected as push-pull power amplifiers.

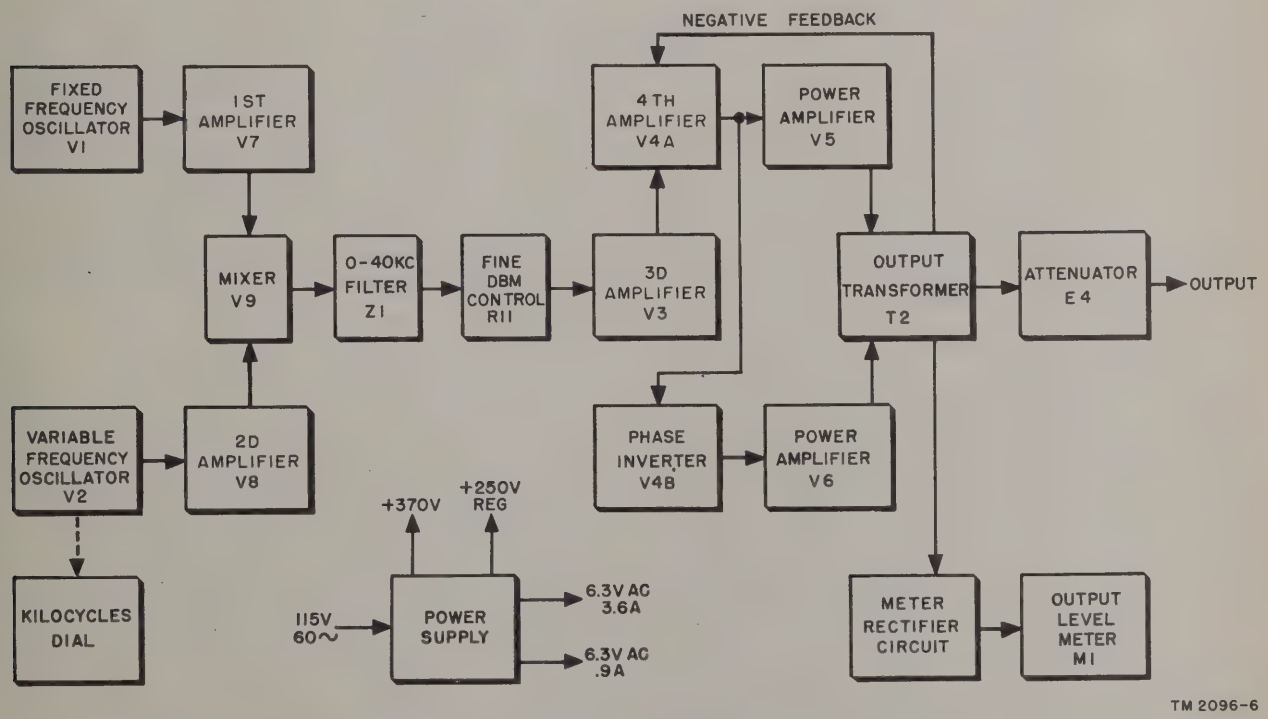

Figure 8. Signal Generator SG-15/PCM, block diagram.

These tubes are operated as triodes with the screens tied to the plates. Tubes V5 and V6 are driven by the signals, equal in amplitude and opposite in phase, from 3d and 4th amplifier tubes V3 and V4A, and a push-pull output signal is developed across the primary of output transformer T2. Transformer T2 couples the output of these tubes to the input of COARSE DBM attenuator E4. The tertiary winding of transformer T2, connected in a negative feedback arrangement to the cathode of 4th amplifier tube V4A, and an output resistance network are the controlling factors in maintaining an output impedance of 600 ohms.

j. METER RECTIFIER CIRCUIT. The meter rectifier circuit consists of rectifiers CR1, CR2, CR3, and CR4, 1N69 crystal diodes connected in a full-wave bridge rectifier circuit. This circuit converts the a-c signal to dc and applies it to OUTPUT LEVEL meter M1, a d-c milliammeter calibrated in db. The meter rectifier circuit response is flat over the entire frequency range of the signal generator.

k. POWER SUPPLY. Line voltage is applied to the primary of transformer T3 when switch S2 is in the ON position. The primary of the transformer has two windings. PRIMARY VOLTAGE switch S1 connects these windings in parallel for use with a 115-volt line when the switch is in the 115 V position, and in series for use with a 230-volt line when the switch is in the 230 V position. The secondary of transformer T3 consists of four windings. Winding 5-7 delivers 750 volts across the plates of rectifier tube V13, a 5Y3GT full-wave rectifier, winding 12-13 delivers 5 volts to the filament of tube V13, winding 10-11 delivers 6.3 volts to the filament of voltage control tube V12, and winding 8-9 supplies 6.3 volts to the filaments of all the remaining tubes in the signal generator. The rectified voltage at the filament of tube V13 is applied to a filter network which supplies +370-volt unregulated screen and plate power to power amplier tubes V5 and V6. The +370-volt output of the rectifier filter also is applied to voltage control tube V12 and voltage control amplifier V10, the circuits of which supply +250 volts regulated voltage for fixed and variable oscillator tubes V1 and V2, 3d and 4th amplifier tubes V3 and V4A, phase inverter V4B, 1st and 2d amplifier tubes V7 and V8, and mixer V9.

Section II. CIRCUIT ANALYSIS

45. Fixed Frequency Oscillator (Tube V1)

a. The fixed frequency oscillator consists of tube V1 and associated circuit elements. Tube V1 is a type 6J5 triode connected as a tuned-grid cathode-coupled oscillator. Figure 9 shows a simplified schematic diagram of this circuit.

b. When plate voltage is applied to fixed frequency oscillator tube V1, plate current begins to flow and a positive voltage appears at the cathode of this tube. The positive voltage from the cathode of tube V1 is applied to the grid tank circuit at point A, thus creating an unbalance in this circuit and causing it to begin to oscillate. Tube V1 is self-biased by the flow of current through cathode resistor R3, which develops d-c bias for the grid of the tube.

c. The tank circuit for tube V1 is a network consisting of inductor L1 and four parallel branches of capacitance—the first, capacitor C1, the second, capacitor C2, the third, capacitor C3, and the fourth, capacitor C5 in series with parallel capacitors C6 and C7. The oscillatory voltage in this tank circuit is applied to the grid of tube V1 and amplified. In addition to d-c bias, a voltage is developed across cathode resistor R3. This voltage is fed back to the tank circuit through resistor R2 to maintain oscillation.

d. Resistor R1 is the plate resistor of tube V1. Capacitor C4 is the plate bypass capacitor and serves as an r-f (radio-frequency) connection from the plate of tube V1 to ground and to the grounded end of the tank circuit. The r-f voltage across resistor R3 also supplies the output voltage of the oscillator. Resistor R45 and capacitor C31A form a filter network, and capacitor C31A decouples the plate voltage of tube V1 from the B+ supply.

e. The fixed frequency oscillator circuit is tuned to approximately 100 kc at the time of manufacture by means of capacitor C2. Read-

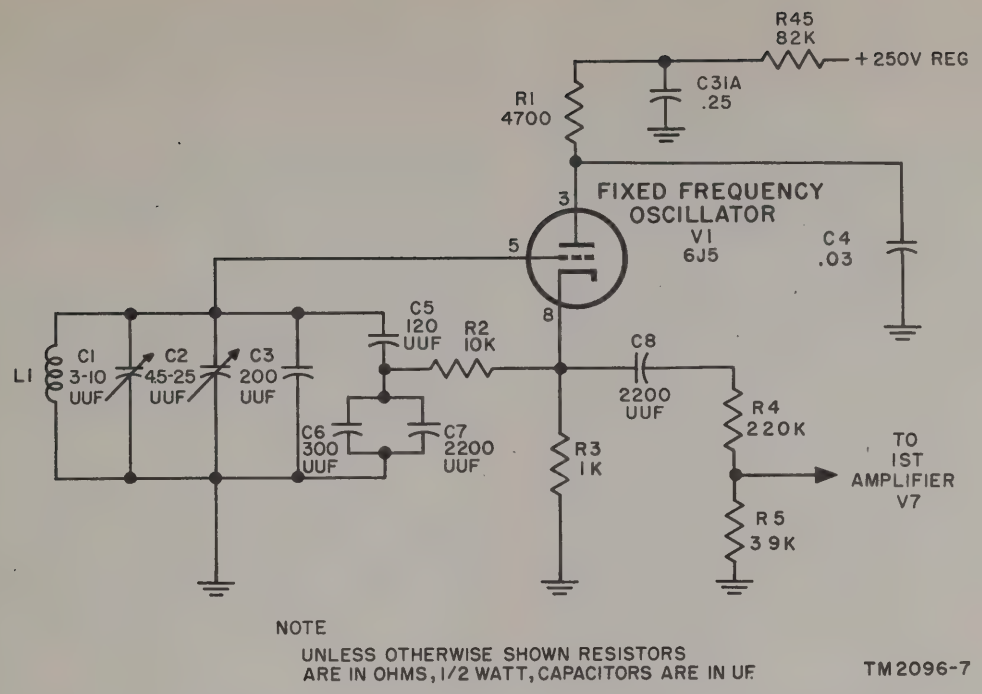

Figure 9. Signal Generator SC-15/PCM, fixed frequency oscillator, simplified schematic diagram.

justment of this circuit is not necessary except after major repairs (par. 74). Fine tuning is accomplished by adjustment of ZERO BEAT ADJ capacitor C1. This control is used to obtain zero beat between the fixed frequency oscillator and the variable frequency oscillator (par. 16*c*).

46. Variable Frequency Oscillator (V2)

a. CIRCUIT ANALYSIS. (1) The variable frequency oscillator consists of tube V2 and associated circuit elements (fig. 29). Tube V2 is a type 6J5 triode connected as a tuned-grid cathode-coupled oscillator in a manner similar to that of fixed frequency oscillator tube V1 (par. 45, fig. 9).

(2) As with fixed frequency oscillator tube V1, plate voltage applied to variable frequency oscillator tube V2 causes a positive voltage to appear at the cathode of the tube. This cathode voltage, applied to the grid tank circuit, creates an unbalance in the tank circuit and causes it to oscillate.

(3) The tank circuit for tube V2 consists of inductor L2 and capacitors C9, C10, C11, C13, C14, and C15. Unlike capacitor C3 in the tank circuit of tube V1, capacitor C11 is a variable temperature-compensating capacitor with a negative coefficient of 500 parts per million degree Centigrade. This capacitor is adjusted during manufacture to keep the drift of the output frequency of the signal generator within limits. Oscillatory voltage created in the tank circuit is applied to the grid of tube V2 and amplified. Oscillation is maintained by a voltage developed across cathode resistor R8 and fed back to the tank circuit through resistor R7.

(4) Resistor R6 is the plate load resistor for tube V2. Plate bypass capacitor C12 connects the r-f voltage from the plate of tube V2 to ground, and the r-f voltage across cathode resistor R8 supplies the output voltage of the oscillator. A filter network is formed by resistor R46 and capacitor C31B, and capacitor C31B decouples the plate voltage of tube V2 from the B+ supply.

(5) The output of tube V2, developed across cathode resistor R8, is coupled to a voltage dividing network by capacitor C16. The signal at the junction of voltage dividing resistors R9

and R10 is applied to the control grid (pin 4) of 2d amplifier tube V8.

(6) The variable frequency oscillator circuit is variable in frequency from slightly below 100 kc to slightly above 135 kc. FREQUENCY capacitor C9 is the main tuning control (subpar. *b* below). The KILOCYCLES dial, which is mechanically coupled to this control, indicates the output frequency of the signal generator as adjusted by the FREQUENCY control. The kilocycles dial is calibrated as follows: equal gradations of 10 cps in the frequency range of 200 through 1,000 cps, equal gradations of 20 cps in the frequency range of 1,000 through 2,000 cps, and equal gradations of 50 cps in the frequency range of 2,000 through 35,000 cps. The range of the variable frequency oscillator is determined at the time of manufacture by adjustment of variable FREQUENCY capacitor C9 and variable capacitor C10. Readjustment of this circuit should not be necessary except after major repairs (par. 74).

Caution: Be extremely careful not to interfere with the electrical and mechanical elements of the variable frequency oscillator. Loss of calibration accuracy will result.

b. MECHANICAL THEORY. Frequency capacitor C9 and the KILOCYCLES dial (fig. 10) are positioned through the oscillator gear train as follows:

(1) The upper drive gear, located on the FREQUENCY knob shaft, rotates as the knob is turned and drives the lower drive gear.

(2) The lower drive gear is mounted on a shaft extension connected directly to capacitor C9. As the FREQUENCY knob is turned and the shaft rotates, the capacitance of capacitor C9 changes, thus varying the frequency output of the oscillator.

(3) The lower drive gear also meshes with the idler gear assembly on its right. The idler gear assembly in turn causes rotation of the dial and dial gear assembly. The hairline indicator is secured to the dial gear shaft, which is stationary.

(4) Since the calibrations on the dial face form a spiral, a sliding shutter is provided to section off a small area of the scale.

(5) As the dial gear assembly rotates, the intermediate gear turns, causing its shaft and the rack driving gear to rotate.

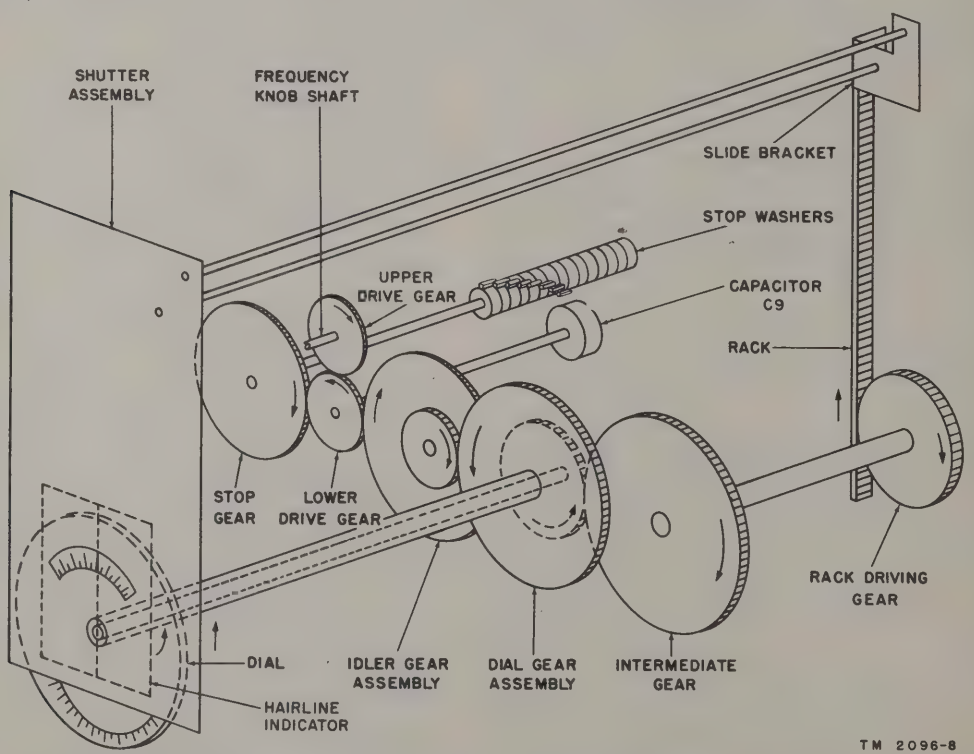

Figure 10. Signal Generator SG-15/PCM, oscillator assembly, simplified mechanical schematic diagram.

(6) The shutter assembly and slide bracket are mounted on the upper end of the rack. As the rack drive gear rotates, the rack and shutter assembly are raised and lowered to provide a viewing area on the dial corresponding to the variation of capacitor C9. Thus, the frequency output of the oscillator can be read directly from the dial.

(7) The lower drive gear also meshes with the stop gear located on the left side of the oscillator assembly. This gear is mounted on a shaft with 15 stop washers. Each washer is provided with a stop which engages the stop of the next washer.

(8) When the shaft is rotated, the first washer engages the stop of the second washer. Further rotation of the shaft causes both washers to rotate.

(9) As each additional rotation is made, the adjacent stop washer turns until the stop of the final washer engages a stationary stop and the shaft cannot be rotated farther. This stopping arrangement limits rotation of the shaft in both directions.

47. Amplifier and Mixer Circuit (Tubes V7, V8, and V9)

The amplifier and mixer circuit (fig. 11) consists of 1st amplifier tube V7, 2d amplifier tube V8, mixer tube V9, and the circuit elements associated with these tubes. The outputs of the fixed and variable frequency oscillators are amplified in the corresponding amplifier stages and applied to the mixer, which produces a beat frequency. The beat frequency is the difference between the two applied signal frequencies.

a. 1ST AMPLIFIER (TUBE V7). (1) The 1st amplifier consists of tube V7, transformer T1, and their associated circuit elements. Tube V7 is self-biased by the flow of current through cathode resistor R29. Resistor R28 is the dropping resistor for the screen of tube V7, and capacitor C24A is the bypass capacitor for the screen of this tube.

(2) The plate of tube V7 is connected to the +250-volt regulated supply through the primary of transformer T1. This transformer is a double-tuned transformer used as an interstage transformer to apply the output of tube

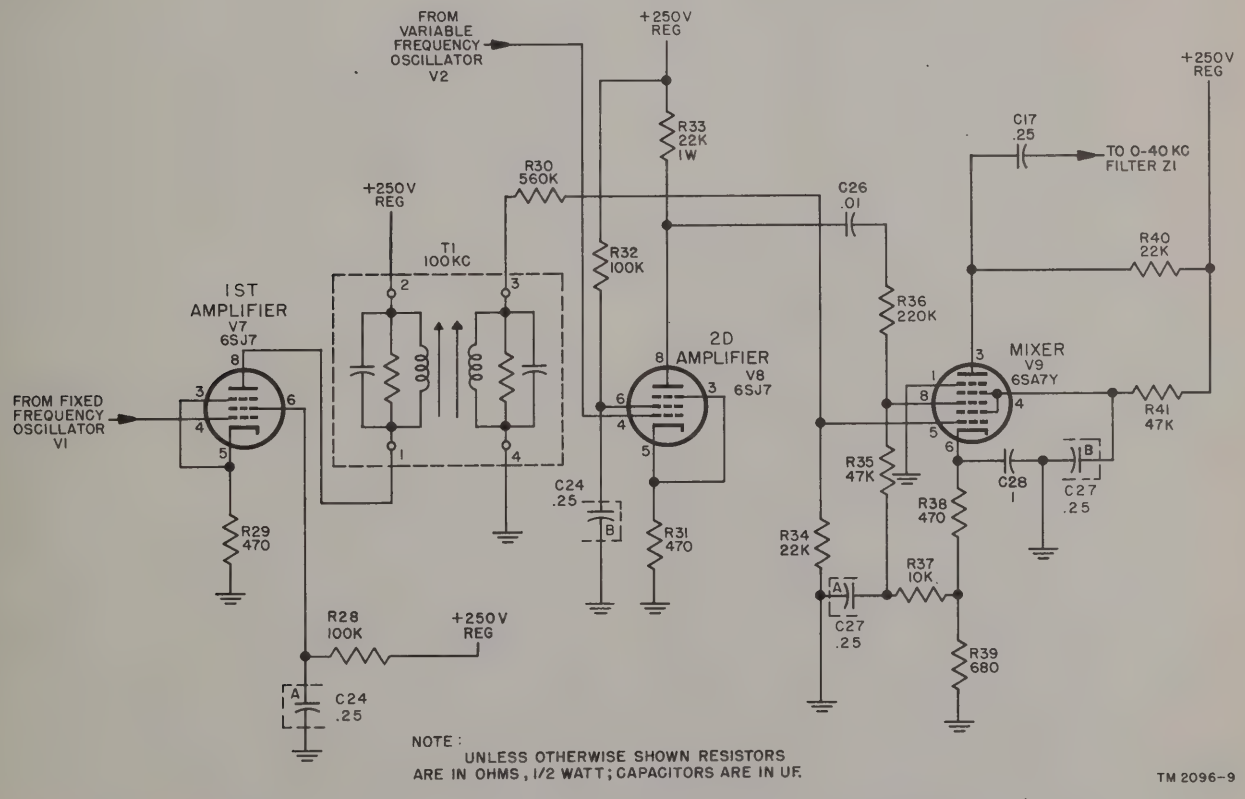

Figure 11. Signal Generator SG-15/PCM, amplifier and mixer circuit, simplified schematic diagram.

V7 to the mixer. Both the primary and the secondary of transformer T1 are tuned to 100 kc by fixed capacitors which are part of the transformer assembly. Transformer T1 is adjusted for maximum output by means of tuning slugs which vary the inductance of the primary and secondary coils. This adjustment is made at the time of manufacture and, ordinarily, readjustment should not be necessary (par. 77).

(3) The output of fixed frequency oscillator tube V1 is applied to tube V7 where it is amplified and applied to transformer T1. The output, which is developed across the primary of transformer T1, is induced into the secondary of this transformer and applied through a voltage divider consisting of resistors R30 and R34 to control grid 1 (pin 5), one of the two control grids of mixer tube V9.

b. 2D AMPLIFIER (TUBE V8). The 2d amplifier consists of tube V8 and its associated circuit elements. This tube is self-biased by the flow of current through cathode resistor R31. Screen voltage is applied through screen-dropping resistor R32, and the screen of tube V8 is bypassed by capacitor C24B. The output of variable frequency oscillator tube V2 is applied to the grid of tube V8. The amplified signal developed across plate load resistor R33 is coupled through capacitor C26 to control grid 3 (pin 8) of mixer tube V9.

c. MIXER (TUBE V9). (1) The mixer consists of tube V9 and its associated circuit elements. The amplified 100-kc output of tube V7 is applied to control grid 1 (pin 5) of tube V9. Voltage-dividing resistors R34 and R30 and the secondary winding of transformer T1 provide d-c connection from this grid to ground. Grid bias is obtained from the voltage drop caused by the flow of current through the cathode resistor, which consists of resistors R38 and R39 in series. The signal from 2d amplifier tube V8 —100 kc to 135 kc, depending on the setting of the FREQUENCY control—is coupled through capacitor C26 and an a-c voltage divider consisting of resistors R35 and R36 to control grid 3 (pin 8) of mixer tube V9.

(2) Capacitor C27A serves as the r-f ground return for this voltage divider. Control grid 3 (pin 8) is biased by the voltage drop resulting from current flow through resistor R38, one of the two series-connected cathode resistors. Capacitor C28 is the cathode bypass capacitor. Further filtering of the d-c bias voltage for control grid 3 (pin 8) of tube V9 is provided by the network comprised of resistor R37 and capacitor C27A. Resistor R41 is the screen-dropping resistor and capacitor C27B is the screen bypass capacitor. As a result of the application of the two signals to the mixer, various signals are present at the plate of this tube. These are, principally, the two applied signals —their sum and their difference, or the beat frequency. The output of the plate circuit is coupled through capacitor C17 to the 0- to 40-kc filter Z1. Resistor R40 is the plate load resistor of mixer V9.

48. 0- to 40-kc Filter Z1

The output of mixer tube V9 is applied to the 0- to 40-kc filter Z1 (fig. 12). This applied signal consists of both the desired beat frequency, which is the difference between the output of the variable frequency oscillator and that of the fixed frequency oscillator, and various undesired frequencies (the frequencies of the two respective oscillators, their sum, their harmonics, etc.). To be usable, the beat frequency must be separated from these undesired frequencies. This is accomplished by the 0- to 40-kc filter Z1. This filter is an inductance-capacitance network which presents a low-impedance path to frequencies in the 0- to 40-kc band and a very high impedance to others. Thus, the desired frequencies are passed by filter Z1 and all others are rejected. The output of the filter is developed across FINE DBM potentiometer R11. This potentiometer is used as a voltage divider to permit adjustment of the amount of filter output voltage which is applied to 3d amplifier tube V3.

49. 3d Amplifier (Tube V3)

The 3d amplifier consists of tube V3 and its associated circuit elements (fig. 12). This tube is self-biased by the flow of current through cathode resistor R13. Resistor R12 is the plate load resistor of tube V3. The output of the 0- to 40-kc filter is applied through the FINE DBM control to the grid of tube V3. The amplified output signal of tube V3 is coupled through capacitor C18 to the grid of 4th amplifier tube V4A.

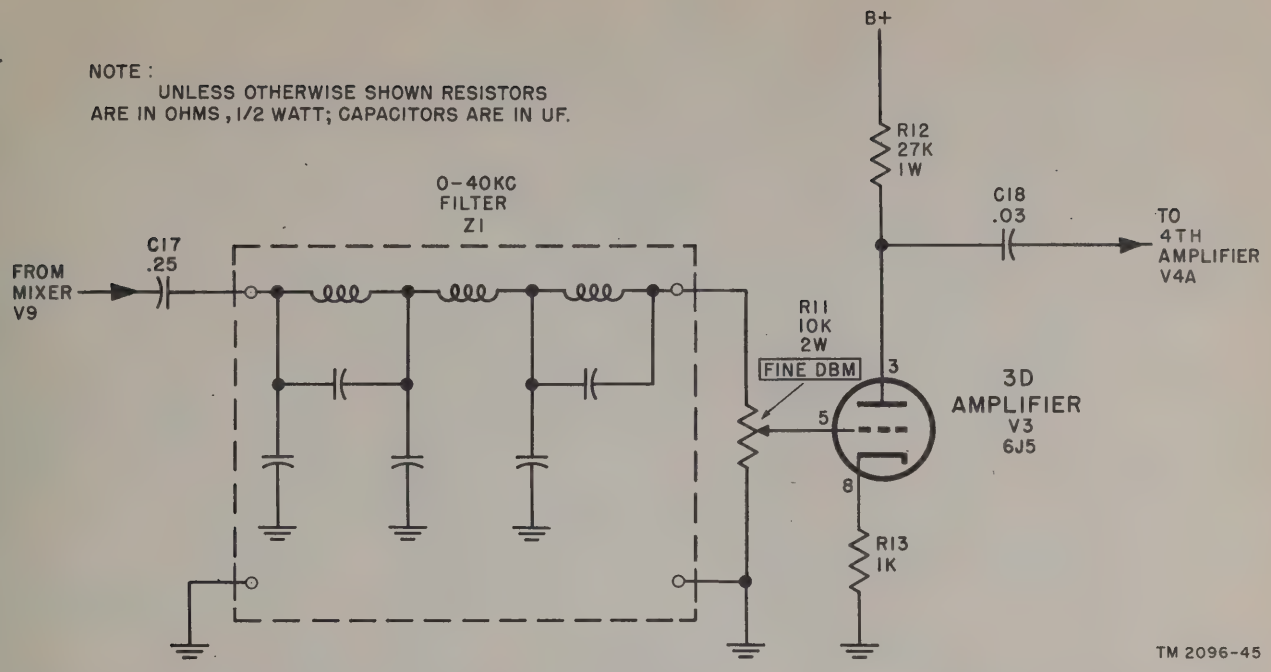

Figure 12. Signal Generator SG-15/PCM, 0- to 40-kc filter and 3d amplifier, simplified schematic diagram.

50. 4th Amplifier and Phase Inverter (Tube V4)

The 4th amplifier and phase inverter consists of tube V4 and its associated circuit elements. The first section of tube V4, designated V4A, is the 4th amplifier used to increase the amplitude of the signal applied from tube V3. The second section of tube V4, designated V4B, is the phase inverter. Tube V4B is used as an inverter and amplifier to produce a signal of the same amplitude but of opposite polarity to the output of tube V4A to drive a pair of push-pull power amplifier tubes, tubes V5 and V6.

a. 4TH AMPLIFIER (TUBE V4A). The output of 3d amplifier tube V3 is coupled through capacitor C18 to the grid of 4th amplifier tube V4A. Resistor R14 is the grid resistor for tube V4A, while resistor R16 is the cathode bias resistor. Resistor R15 is the plate load resistor. The signal applied to tube V4A is amplified, and the output at the plate is applied through capacitor C19 to the control grid of power amplifier tube V5 and to voltage dividing resistors R21 and R22 in series. Negative feedback from the tertiary (terminals 4-5) of transformer T2 (par. 51*b*) to the cathode of tube V4A minimizes distortion and maintains low internal impedances.

b. PHASE INVERTER (TUBE V4B). (1) The signal from 4th amplifier tube V4A, impressed on voltage dividing resistors R21 and R22, is coupled through capacitor C20 to the grid of tube V4B. This signal is amplified and inverted by tube V4B, and the output at the plate is coupled through capacitor C21 to the control grid of power amplifier tube V6.

(2) The output of tube V4A passes through capacitor C19 to resistors R21 and R22, which form an a-c voltage divider for tube V4A (subpar. *a* above); the output of tube V4B passes through capacitor C21 to resistors R23 and R22, which form an a-c voltage divider for tube V4B. The output of both tubes, V4A and V4B, appears across resistor R22. Since the voltages of resistors R21 and R23 are always of opposite polarity, the voltage across resistor R22 is the difference between the two applied voltages.

(3) Normally, the voltage across resistor R22 is very small. The circuit constants are such that, under normal conditions, the voltages applied to the grids of tubes V5 and V6 are equal in amplitude and opposite in phase. If any unbalance should occur between the circuits of tubes V4A and V4B, however, thus causing a variation in output of one of the two

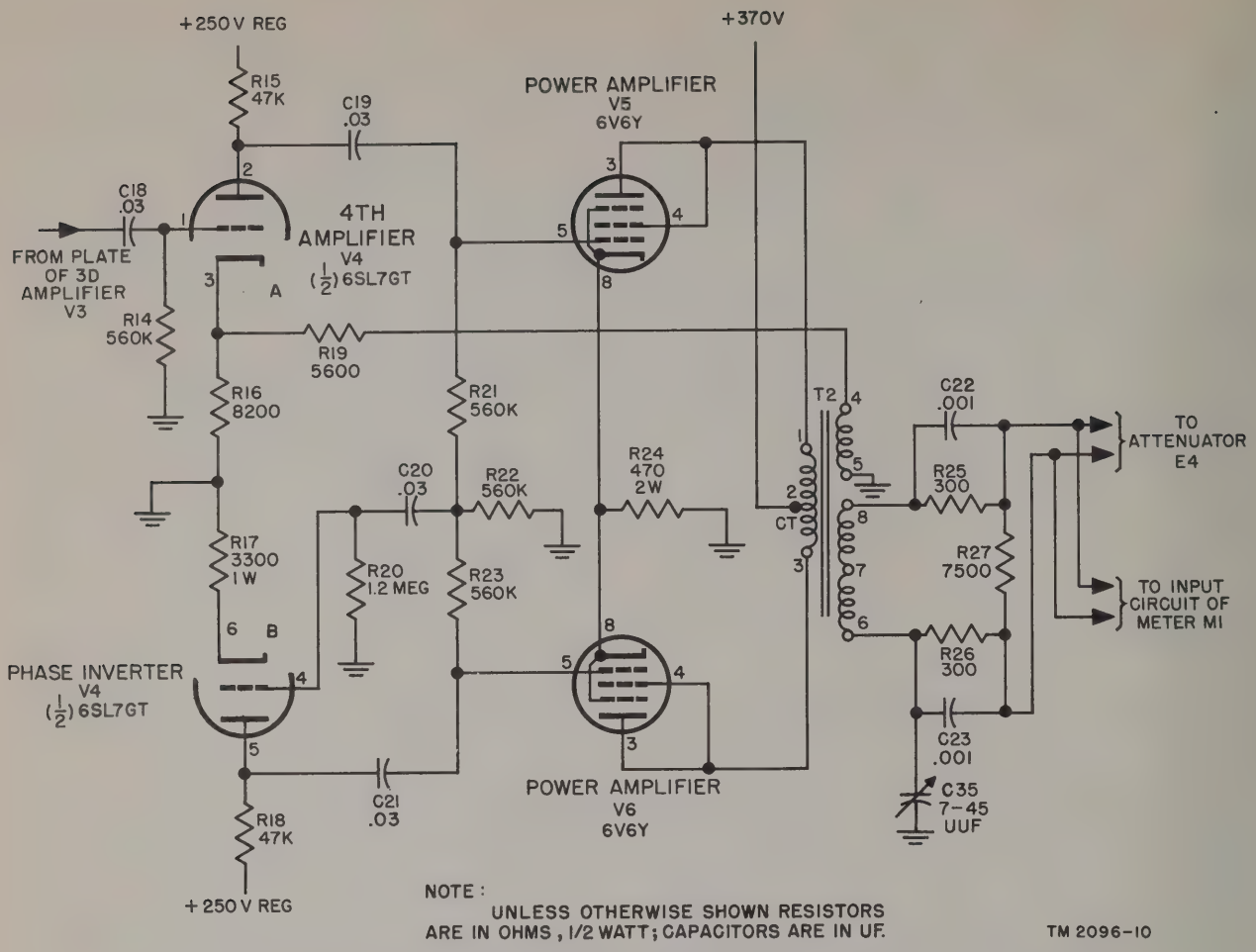

Figure 13. Signal Generator SG-15/PCM, 4th amplifier, phase inverter, and power amplifier, simplified schematic diagram.

tubes, the voltage drop across resistor R22 would increase or decrease in a direction tending to counteract the effect of the unbalance. For example, if the amplitude of the signal at the plate of tube V4B should decrease, the voltage drop caused by this signal across resistor R22 would decrease and the signal applied to tube V4B would be greater. This would increase the output of tube V4B and reestablish the balance between the two circuits. Likewise, if the output of tube V4B were to increase, it would tend to cancel out more of the signal from tube V4A across resistor R22. Thus, the input to tube V4B would be decreased, tending to reduce the output of tube V4B and to reestablish the balance between the two circuits.

51. Power Amplifier Stage

The power amplifier stage (fig. 13) consists of power amplifier tubes V5 and V6, transformer T2, and their associated circuit elements.

a. Power Amplifier Tubes V5 and V6. Tubes V5 and V6 are two type 6V6Y beam-power tubes connected as push-pull power amplifiers. The signal from tube V4A is applied to the control grid of tube V5 and that from tube V4B to the control grid of tube V6. These signals are equal in amplitude and opposite in phase. Resistors R21 and R23 act as the grid resistors for tubes V5 and V6, respectively, with resistor R22 in common for both tubes (par. 50*b* (2)). Resistor R24 is the common cathode resistor. Tubes V5 and V6 are operated as triodes with the screens tied to the plates. A +370-volt unregulated d-c voltage is supplied to the plates from the power supply through the center tap of the primary of output transformer T2. The applied signals are amplified in tubes V5 and V6, and a push-pull out-

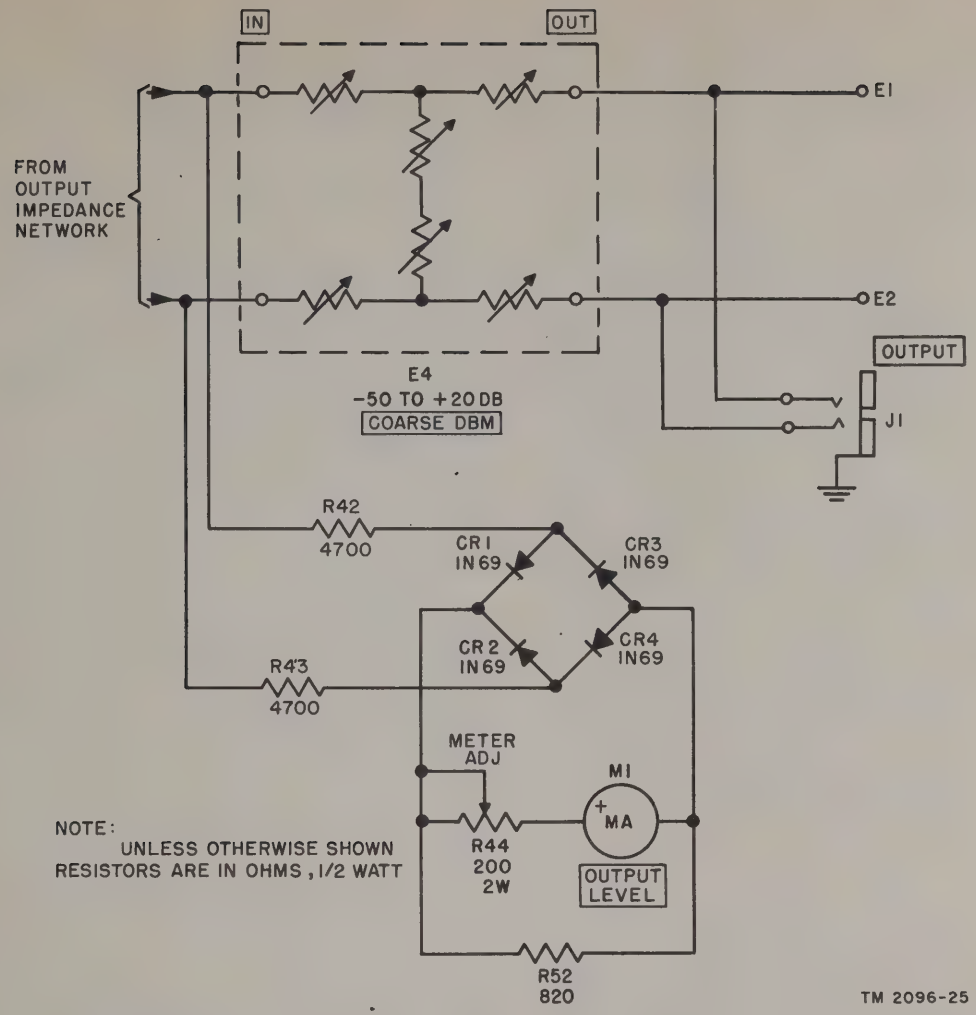

Figure 14. Signal Generator SG-15/PCM, output and meter rectifier circuits, simplified schematic diagram.

put is developed across the primary of output transformer T2.

b. OUTPUT. (1) The signal impressed across the primary of output transformer T2 causes a corresponding signal to be induced in the secondary winding (terminals 6-8) of this transformer. A tertiary winding (terminals 4-5) is connected in a negative feedback arrangement, through resistor R19, to the cathode of 4th amplifier tube V4A. This negative feedback reduces the output impedance of transformer T2 (terminals 6-8) to approximately 100 ohms. Resistors R25 and R26, together with capacitors C22 and C23 and resistor R27, form an output impedance network. The impedances in the output circuit, looking back from the input to attenuator E4, combine to equal a balanced 600 ohms. The output impedance balance is adjusted at the time of manufacture by capacitor C35—be careful not to disturb this adjustment.

(2) The signal from the output impedance network consisting of resistors R25 and R26, capacitors C22 and C23, and resistor R27 goes through COARSE DBM attenuator E4 (fig. 13). This attenuator has a balanced impedance of 600 ohms in the frequency range of 200 cycles through 35 kc. The attenuator has eight steps of attenuation of 10 db per step, from 0 through 70 db, and a ninth step which short-circuits the output terminals. The output is taken either at OUTPUT terminals E1 and E2, or at OUTPUT jack J1 which is connected in parallel with the OUTPUT terminals. GND terminal E3 is the chassis ground connection.

(3) OUTPUT LEVEL meter M1, complete with a crystal diode full-wave bridge-type rec-

tifier consisting of CR1, CR2, CR3, and CR4, monitors the input voltage applied to attenuator E4 (fig. 14). Series resistors R42 and R43 reduce the bridging loss of this connection with respect to the transmission path through attenuator E4 and apply the proper voltage to the rectifier circuit. Signals entering this rectifier circuit are passed on to OUTPUT LEVEL meter M1. This meter is a d-c milliammeter with a 0- to 1-ma range. It has a single scale calibrated from —4 to +6 db. The response of the metering circuit is flat over the entire output frequency range of the signal generator. Resistor R52 and potentiometer R44 allow an initial calibration of the metering circuit by adjustment of potentiometer R44. This adjustment is made at the time of manufacture. Be careful not to disturb the setting of potentiometer R44 (par. 78).

(3) The output power of the signal generator is the sum of the setting of the COARSE DBM control (—50 to +20 dbm graduated in steps of 10 db) and the reading of the OUTPUT LEVEL meter M1 (—4 to +6 db).

52. Power Supply Circuits

a. GENERAL. Signal Generator SG-15/PCM is provided with an internal power supply which furnishes +370 volts unregulated voltage for tubes V5 and V6, +250 volts regulated voltage for tubes V1 through V4, and V7 through V9, and filament voltage for all the tubes used in the signal generator.

b. RECTIFIER POWER CIRCUIT (fig. 15). (1) *Input.* (*a*) *Primary, transformer T3.* Line voltage is applied to the primary of power transformer T3 when power ON-OFF switch S2 is in the ON position. This switch is a double-pole, single-throw toggle switch mounted on the front panel of the generator. The primary of transformer T3 consists of two separate windings which are connected by means of PRIMARY VOLTAGE switch S1. This is a double-pole, double-throw toggle switch mounted on the front panel of the generator and having positions designated 115 V and 230 V. When switch S1 is set to the 115 V position, the two sections of the transformer primary are connected in parallel for use with a 115-volt line. When the switch is in the 230 V position, the two transformer primary windings are connected in series for use with a 230-volt line. Fuse F1 is connected in series with one side of the line and the primary windings of transformer T3 to protect this circuit from overload.

(b) *Secondary, transformer T3.* Transformer T3 has four secondary windings. The high-voltage winding (taps 5-6-7) is center-tapped and applies 750 volts at 110 ma across the plates of rectifier tube V13. Three filament windings deliver the following voltages: winding A (taps 12-13) delivers 2 amperes at 5 volts to the filament of tube V13, winding B (taps 10-11) delivers .9 ampere at 6.3 volts to the

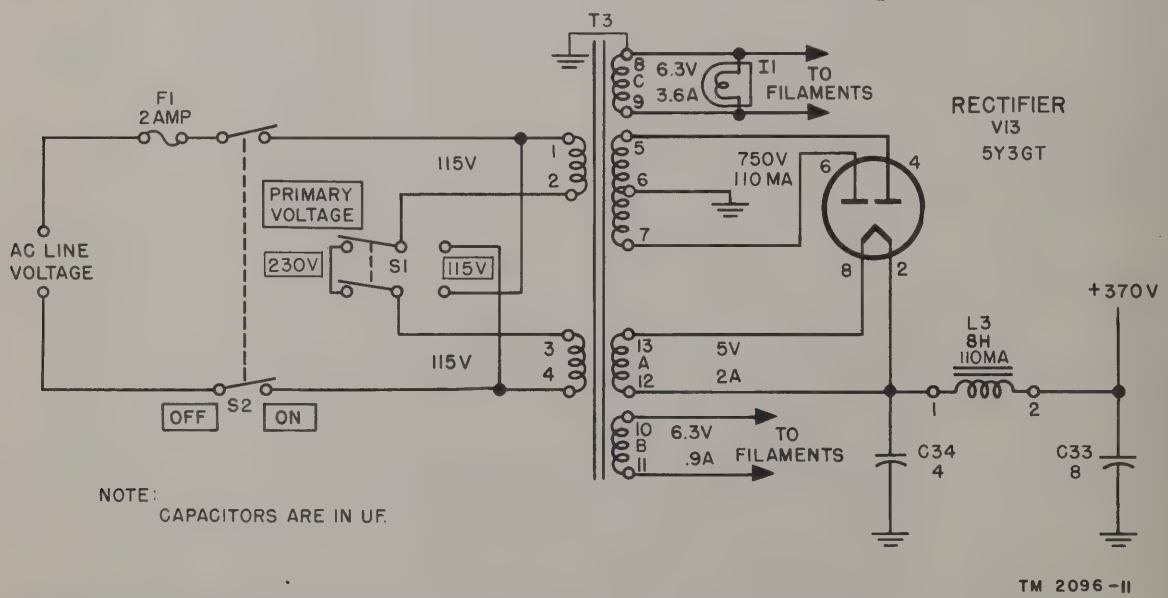

Figure 15. Signal Generator SG-15/PCM, rectifier power circuit, simplified schematic diagram.

filament of tube V12, and winding C (taps 8-9) delivers 3.6 amperes at 6.3 volts to the filaments of the remaining tubes, which are connected in parallel. Indicator lamp I-1, located on the front panel of the generator, is connected across winding C and lights when power is applied to the signal generator.

(2) *Rectifier (tube V13).* Rectifier tube V13 is a type 5Y3GT full-wave rectifier. The 750-volt output of the high-voltage secondary (taps 5-7) of transformer T3 is applied across the plates of tube V13. These plates conduct alternately on each half-cycle of the applied voltage and a pulsating dc appears at their common filament. This rectified voltage is applied to a filter network.

(3) *Filter network.* The rectified voltage at the filament of tube V13 is applied to the filter network, a pi-type capacitor input network consisting of capacitor C34, choke coil L3, and capacitor C33. This network reduces the ripple content in the pulsating d-c output of the rectifier. The +370-volt output of the filter network is applied to tubes V5 and V6 through the center tap of the primary of output transformer T2 and to tubes V10 and V12 of the regulated +250-volt power supply.

c. Regulated +250-Volt Power Supply (fig. 16). The regulated +250-volt power supply consists of voltage control tube V12, voltage control amplifier V10, voltage control regulator V11, and their associated circuit elements. This circuit provides a regulated output of +250 volts which is independent of fluctuations in either the applied voltage or the load.

(1) *Voltage control tube V12.* Voltage control tube V12 is a type 6L6GAY beam-power tube connected as a triode with the screen tied to the plate. The cathode of this tube is the output point of the circuit. A voltage divider consisting of resistor R49, B+ ADJ potentiometer R50, and resistor R51 in series is connected between this point and ground. Plate voltage is supplied by the +370-volt output of the rectifier filter.

(2) *Voltage control amplifier V10.* The voltage control amplifier V10 is a 6SQ7 duplex-

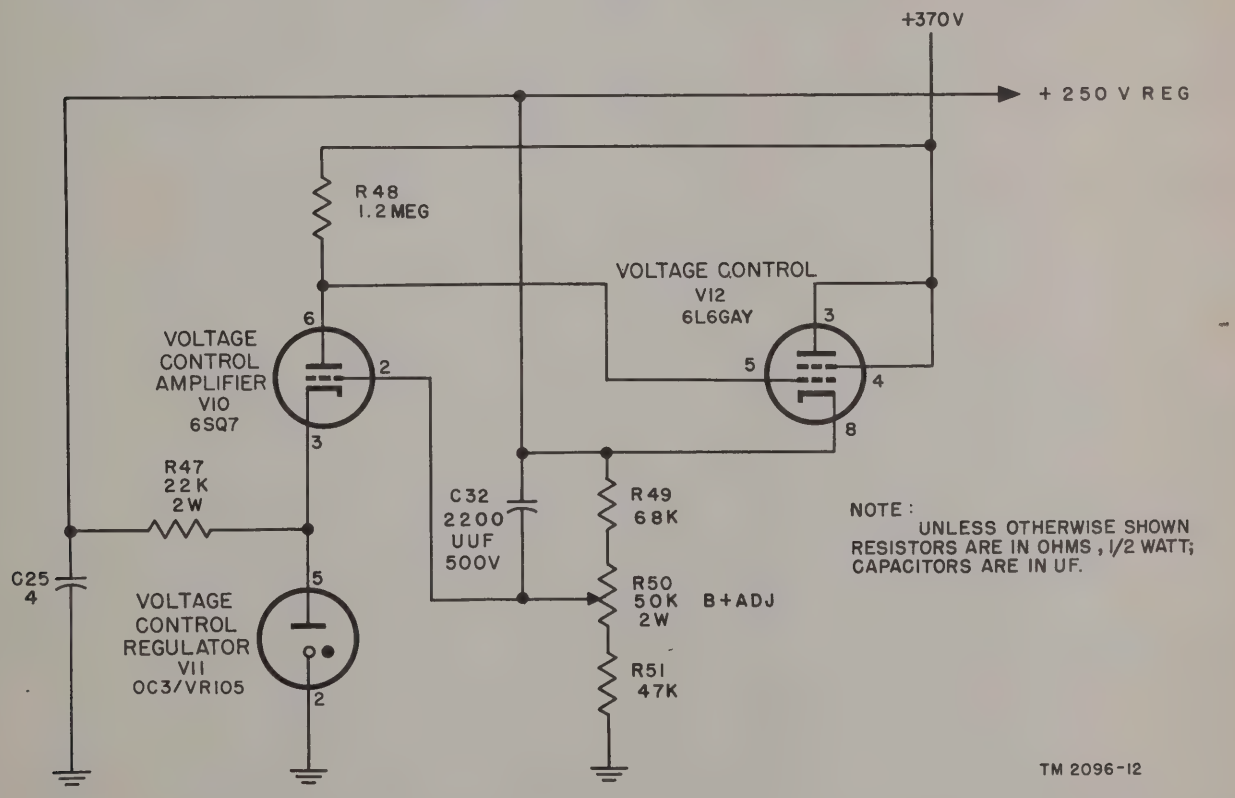

Figure 16. Signal Generator SG-15/PCM, regulated +250-volt supply, simplified schematic diagram.

diode high-mu triode. Since only the triode section of this tube is used, figure 16 eliminates the diode section and shows only the triode. The two diode plates are grounded and do not function in this circuit. The grid of tube V10 is connected to the movable arm of B+ ADJ potentiometer R50. This potentiometer is set to apply slightly less than +105 volts from the voltage divider to the grid of tube V10. This places the grid at a small negative bias, since the cathode is held at approximately +105 volts by voltage control regulator tube V11, which is connected between the cathode of tube V10 and ground. The setting of potentiometer R50 thus sets the operating level of the circuit. Any change in the voltage across the voltage divider, whether due to fluctuations in the output of the rectifier or changes in the load, is applied to the grid of tube V10. Capacitor C32 applies the full voltage change to the grid at once; without this capacitor, every change in grid voltage would be subject to a time delay. Any change in grid voltage is applied to the grid of tube V12, causing a change in conduction in tube V12 in a direction to compensate for the original voltage fluctuation. Resistor R48 is the plate load resistor of tube V10.

(3) *Voltage control regulator (tube V11).* Voltage control regulator tube V11 is a type OC3/VR105 glow discharge tube connected between the cathode of tube V10 and ground. The internal resistance of this tube varies inversely with the applied voltage so that tube V11 maintains the cathode of tube V10 constantly at +105 volts. Resistor R47 drops the applied voltage to the level required for proper operation of tube V11. Capacitor C25 provides additional filtering of the output voltage.

CHAPTER 6

FIELD MAINTENANCE INSTRUCTIONS

Note. This chapter contains information for field maintenance. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and test equipment available and by the skill of the repairman.

Section I. PREPAIR PROCEDURES

53. Tools, Materials, and Test Equipment

In addition to the tools and materials given in paragraph 30, the tools, materials, and test equipment required for reconditioning, adjusting, and repairing Signal Generator SG-15/PCM are listed in subparagraphs *a* and *b* below:

a. TOOLS AND MATERIALS.

Signal Corps stock No.	Name of item and description	Used to
NSNA	BURNISHER, jack sleeve: hardwood pin.	Burnish jack sleeves.
6R41065C	BURNISHER TL-557/U: contact burnisher.	Clean and burnish jack contacts.
6Z2000	CLOTH, crocus: 9″ x 11″.	Clean tube prongs.
6G1516	PASTE, metal polish.	Clean plugs.
6N7531	SOLDER M-31.	Resolder equipment wiring.
6R24617	SOLDERING IRON TL-117.	Resolder equipment wiring.
6Z8666	TOOTHPICKS: hardwood; flat one end, pointed other end.	Clean jack contacts.

b. TEST EQUIPMENT.

Signal Corps stock No.	Name of item and description	Used to
3F3307.11-1	DECIBEL METER ME-22/PCM.	Test signal generator for power output.
3F8100-3	ELECTRONIC MULTIMETER ME-6/U: a-c vacuum-tube voltmeter; ranges — 100 uv to 100v; .01 to 1,000 rms v with external multiplier.	Signal trace circuits of signal generator.
3F3313-2	FREQUENCY METER FR-67/U: direct-reading frequency meter; range — 10 cps to 100 kc per second.	Aline fixed and variable frequency oscillators.
3F4325-352	MULTIMETER TS-352/U: battery operated; ranges— 0 to 1,000 volts ac, 0 to 5,000 volts dc, 0 to 10 amperes dc, and 0 to 30 megohms; consists of Multimeter ME-9/U and Multiplier Kit MX-815/U which extends the range to the 5,000-volt d-c range.	Read a-c and d-c voltages and make resistance tests.
3F5700-177	TUBE TESTER I-177: dynamic mutual conductance type; input 105 to 125 volts, 50/60 cycles.	Test vacuum tubes.
2Z5731-949	TUBE SOCKET ADAPTER KIT MX-949/U.	For use with Tube Tester I-177.

54. Removal of Pluck-out Parts

The vacuum tubes, pilot lamps, and fuses of Signal Generator SG-15/PCM can be removed without unsoldering parts. These parts are called pluck-out parts because they do not require complicated disconnection procedures. No disassembly of the signal generator is necessary except the removal of the cover when vacuum tubes are to be removed.

a. VACUUM TUBES. Remove the cover with a straight upward movement. Lateral movement may damage the spare tubes mounted on the inside of the top flange of this cover. When the tubes have cooled sufficiently, remove the tubes by pulling up with the fingers. Grip glass tubes by the base. Do not rock a tube or jiggle it in its socket if it can be extracted by a straight upward pull. Jiggling a tube in its socket during removal spreads the socket contacts. If a tube does not release easily, move it gently from side to side. Label each tube as soon as it is removed so that it can be replaced in its proper socket.

b. PILOT LAMP. To remove the pilot lamp, unscrew the red lens covering the lamp and remove the bayonet-base lamp by pushing it in and turning it counterclockwise.

c. FUSE. To remove the fuse, push the fuse cap in and turn it in the direction indicated by the arrow on the top. Pull out the cap and fuse. Remove the spare fuse in the same manner.

55. Inspecting, Cleaning, and Testing Removed Parts

a. INSPECTING. (1) *Tubes.* Be sure that the labels on the tubes in the various sockets correspond to the correct tube numbers for those positions. Check with figures 19 and 20. Inspect for cracked bases and for loose or cracked envelopes on glass tubes. Check for bent or broken prongs.

(2) *Pilot lamp.* Inspect the pilot lamp for burned base and broken filament.

(3) *Fuse.* Inspect the fuse visually for continuity, loose ferrules, and charring.

b. CLEANING. Clean the vacuum tubes which have been removed from the signal generator with a clean cloth moistened with solvent (SD). If necessary, clean the prongs of the tubes with crocus cloth.

c. TESTING. (1) *Vacuum tubes.* Use a tube tester to test the vacuum tubes for improper emission, leakage, and short circuits. If a tube tester is not available, place doubtful tubes in a signal generator known to be operating normally.

(2) *Pilot lamp.* Test the pilot lamp for filament continuity with an ohmmeter, or place the lamp in a signal generator known to be in good operating condition.

56. Inspecting and Cleaning Chassis Assembly

a. INSPECTING. Make a visual inspection of the signal generator to determine the general condition of the equipment when it is turned in for repair. Refer to figures 17 through 22 for location of parts in the unit. Remove the cover and the bottom plate and proceed as follows:

(1) Examine the unit for burned insulation and resistors. Examine for wax and oil leakage and any discoloration of apparatus and wiring. Inspect the wiring for broken leads, brittle insulation, and corrosion.

(2) Inspect for broken connections to tube sockets, jacks, terminals, meter, and other apparatus as well as for defective soldered connections. Examine for bare wires touching other wires or the chassis.

(3) Inspect for loose tube sockets.

(4) Test the operation of all switches. They should not bind, and the contacts should close with a slight follow when the switch is operated. Inspect for any corrosion, dirt, or foreign matter which might affect operation. Check for bent or broken switch springs.

(5) Examine the operation of variable resistors and other controls. The shafts should move freely and smoothly without binding.

(6) Inspect the power plug for bent or broken prongs.

(7) Inspect for loose or missing screws, especially those which fasten the tube sockets in place.

(8) If there is no indication of damage or fault, connect the equipment for operation and follow the procedures given in the equipment performance checklist (par. 42) to see if the signal generator is operating properly.

b. CLEANING. (1) Clean the outside of the equipment with a clean, lint-free cloth.

(2) Remove dirt and salt spray from the exterior of the equipment only with a cloth moistened with clear water. Allow the equipment to dry thoroughly before attempting any further cleaning.

(3) Remove the cover from the equipment. Use air pressure, if it is available, to blow out accumulated dust, dirt, sand, lumps of solder, and wire cuttings. Apply the air pressure so that dust is blown away from switch contacts. If air pressure is not available, brush accumulated dust and dirt from the interior of the equipment with a soft bristle brush. Be careful not to damage equipment wiring. Use probe sticks of wood or insulating material to dislodge caked dirt, and use toothpicks or their equivalent for hard-to-reach places.

(4) Remove oil and grease with a cloth moistened with solvent (SD). Wipe dry with a clean, dry cloth.

(5) Remove rust, corrosion, fungus growth, and similar foreign material on the structural framework with #0000 sandpaper or a scratch brush, and clean with solvent (SD) when necessary.

57. Cleaning Jack Contacts

a. CLEANING CONTACTS. (1) To clean the contacts, flush them with carbon tetrachloride applied with a clean toothpick. Dip the flat end of the toothpick into the carbon tetrachloride to a depth of about ½ inch and deposit the liquid on the contacts without rubbing. Hold the contacts slightly separated during this process.

(2) Dip the flat end of another toothpick into the carbon tetrachloride and deposit it on the contacts, also without rubbing, to flush away the dirt that was loosened by the first application. Be careful to keep the carbon tetrachloride away from the insulators.

(3) When the contacts are thoroughly dry, burnish them so that no deposit or residue from the solution or other foreign material remains on the contacts.

b. BURNISHING CONTACTS. (1) Burnish contacts with the steel blade of the contact burnisher. Clean the contact burnisher before using by wiping the blade with a clean, dry cloth. During the burnishing process, wipe the blade frequently with a cloth moistened with carbon tetrachloride.

Caution: Repeated contact of carbon tetrachloride with the skin or prolonged breathing of the fumes is dangerous. Make sure adequate ventilation is provided.

(2) Rub the burnisher against the contacts two or three times. Do not use abrasives other than the burnisher blade.

58. Cleaning Jack Springs and Sleeves

a. CLEANING SPRINGS. To clean the crimps of the tip springs which make contact with the plug, use a plug which has been cleaned recently and from which all cleaning paste has been removed. Insert and withdraw the plug two or three times. It is not practical to clean the tip springs thoroughly. If it is necessary to disassemble the spring assembly for any reason, however, wipe the parts with a clean, dry cloth.

b. CLEANING SLEEVE. (1) *Cleaning with jack sleeve burnisher.* If a portable motor and a flexible shaft are available, place a clean sleeve burnisher in the hand piece of the flexible shaft. If a hand drill is used, place the tool in the hand-drill chuck. When the tool is rotating, insert it into the jack opening with the axis of the tool perpendicular to the face of the jack. Application of the tool for a few seconds should clean the surface of the flare. In some cases, however, it may be necessary to insert the tool at a slight angle to clean spots that are particularly dirty.

(2) *Cleaning with clean cloth.* (*a*) Make a solution of solvent (SD) and a 2 percent by volume of light oil; use 17 drops of oil for each ounce of solvent (SD). Make the solution in quantities of 2 ounces or less. Keep the container tightly corked except when moistening the cloth.

(*b*) Fold a piece of lint-free cloth, about 5 inches long by 1½ inches wide, along its length so that the strip will be about ¾ inch wide. Insert one end of an orange stick into the fold at one end of the cloth and wrap the cloth spirally around the stick so that the folded edge is exposed. There should be about 3 turns of cloth per inch of length. Hold the end of the cloth

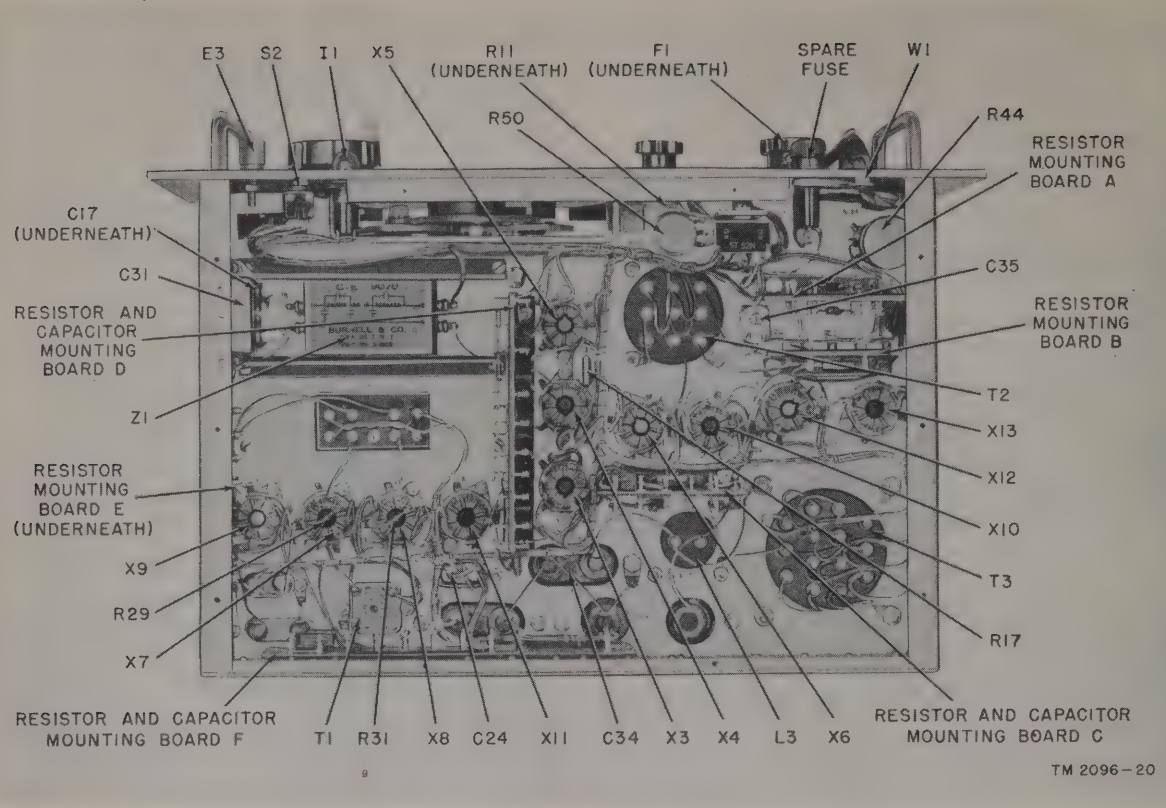

Figure 17. Signal Generator SG-15/PCM, bottom view, location of parts.

with the fingers or fasten it by some suitable means.

(*c*) Moisten the end of the cloth with the solution. Insert the wrapped orange stick into the sleeve of the jack and rub back and forth, contacting all surfaces of the sleeve. Be careful not to touch the springs of the jack any more than is necessary. Repeat this process until the cloth is clean when it is removed from the sleeve.

59. Reassembling Equipment

Replace the tubes and the pilot lamp in their respective sockets. Be sure that each tube is in the correct socket (figs. 19 and 20). Place the fuse in the cap and reinsert the cap and fuse. If a fuse is burned out, replace it with one of equal rating. If a newly replaced fuse blows, there may be trouble in the equipment. Test the power supply circuit before replacing the fuse.

Section II. TROUBLE SHOOTING AT FIELD MAINTENANCE LEVEL

Warning: High voltage is used in the operation of this equipment. Death or serious injury may result if operating personnel do not observe safety precautions.

60. Trouble-shooting Procedures

The first step in locating a fault on defective equipment is to sectionalize the fault. Sectionalization means tracing the fault to the circuit or stage responsible for the abnormal operation. The second step is to localize the fault—that is, to trace it to the defective part responsible for the abnormal condition. Careful observation of the performance of the signal generator may aid in the sectionalization of a fault to a particular circuit or stage. For example, the meter readings under various conditions of operation may indicate whether various controls and their associated circuits are functioning properly.

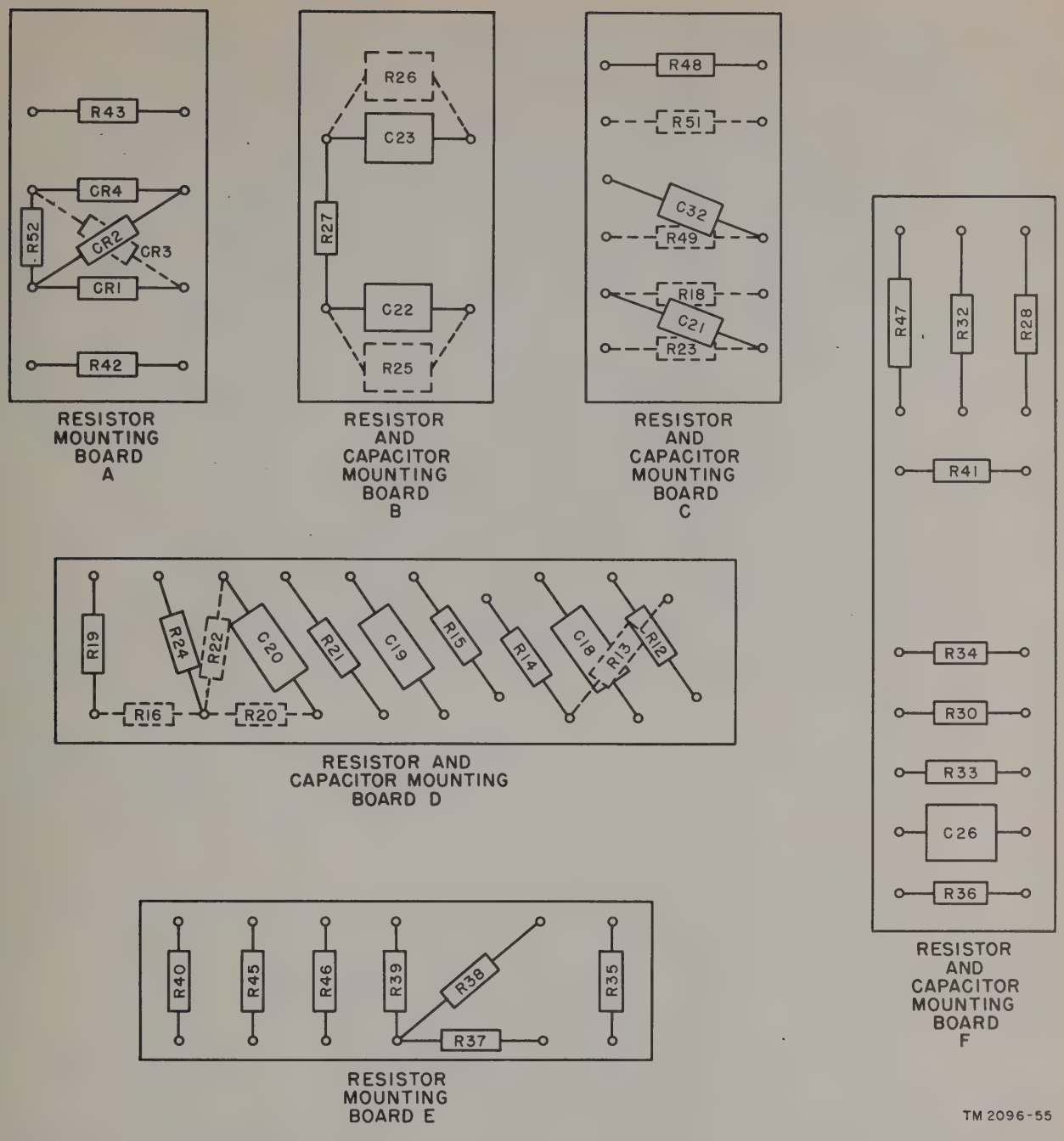

Figure 18. Signal Generator SG-15/PCM, resistor and capacitor mounting boards located on bottom of unit.

Failure of the pilot lamp to light may indicate trouble in the power supply circuit. Some faults can be located by smell, sight, or hearing, such as burned-out resistors, arcing, or shorted transformers. However, the majority of faults must be localized by checking voltage and resistance. The tests outlined below and discussed in paragraphs 64 and 65 will help to isolate the source of trouble.

a. VISUAL INSPECTION. Carefully inspect the equipment to be sure there is no mechanical binding of switches and controls which might damage the equipment. As instructed in paragraph 56, make a visual inspection of the equipment for any sign of damage such as loose or missing screws, nuts, and bolts, loose or poorly soldered connections, dirty jack contacts, overheated resistors, damaged insulation, and ex-

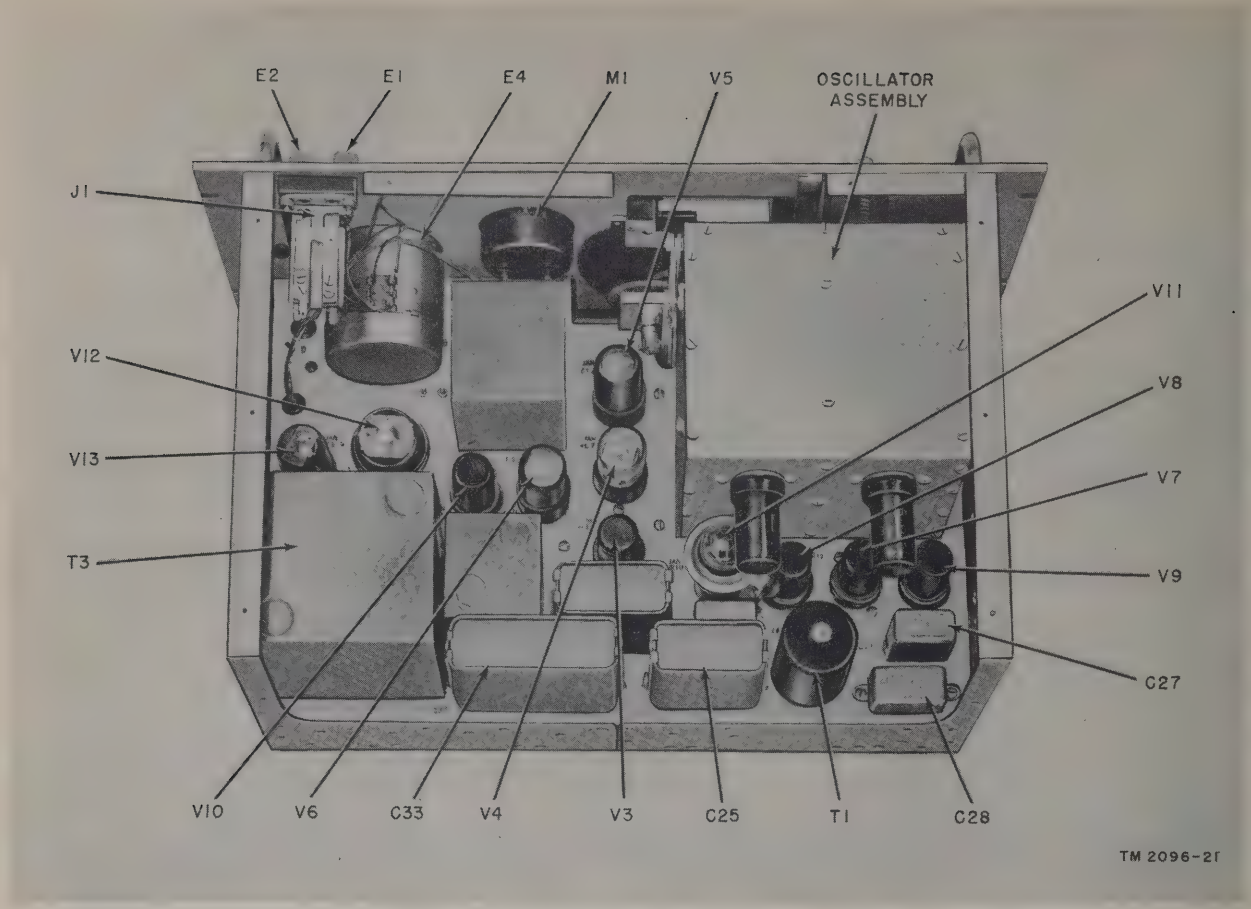

Figure 19. Signal Generator SG-15/PCM, top view, location of parts.

posed wiring which might cause short circuits with other wiring, terminals, or ground. Through such visual inspection, frequently it is possible to discover the trouble or to determine in which circuit the trouble exists. In addition, visual inspection is valuable in that further damage to the equipment as a result of improper maintenance methods may be avoided and future failures forestalled.

b. POWER SUPPLY TEST. The power supply test (par. 64) prevents further damage to the equipment from possible short circuits in the power supply circuit.

c. OPERATIONAL TEST. The operational test (par. 65) may indicate the general location of trouble. In many instances, the information obtained will determine the exact location of the fault. So that this information may be utilized fully, all symptoms must be interpreted in relation to one another.

d. TROUBLE-SHOOTING CHART. Trouble symptoms can be sectionalized and, in some cases, localized by checking the symptoms on the trouble-shooting chart (par. 66).

e. INTERMITTENT CONDITIONS. When making the tests and inspections in subparagraphs *a* through *d* above, do not overlook the possibility of intermittent trouble. If an intermittent trouble is present, try to make it appear by tapping or jarring the equipment. The trouble may not be in the signal generator but in the installation, in the power cable or output connection, or the trouble may be caused by external conditions such as the power source. Test for such conditions, if possible.

61. Trouble-shooting Data

Several factors must be considered before proceeding with the actual location of trouble.

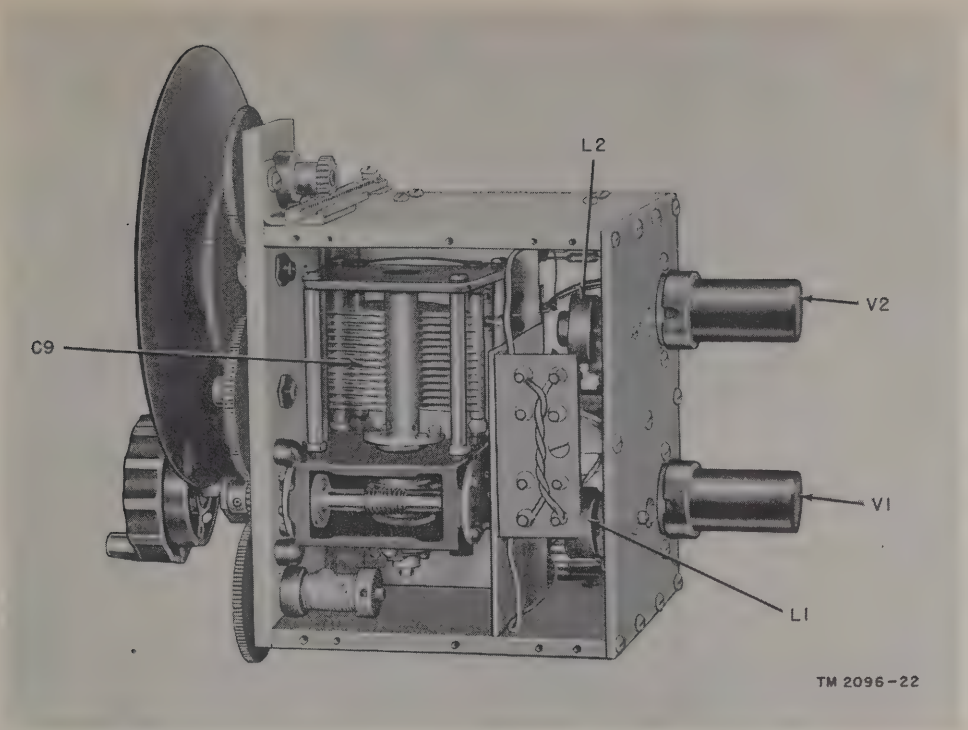

Figure 20. Oscillator assembly, bottom view, location of parts.

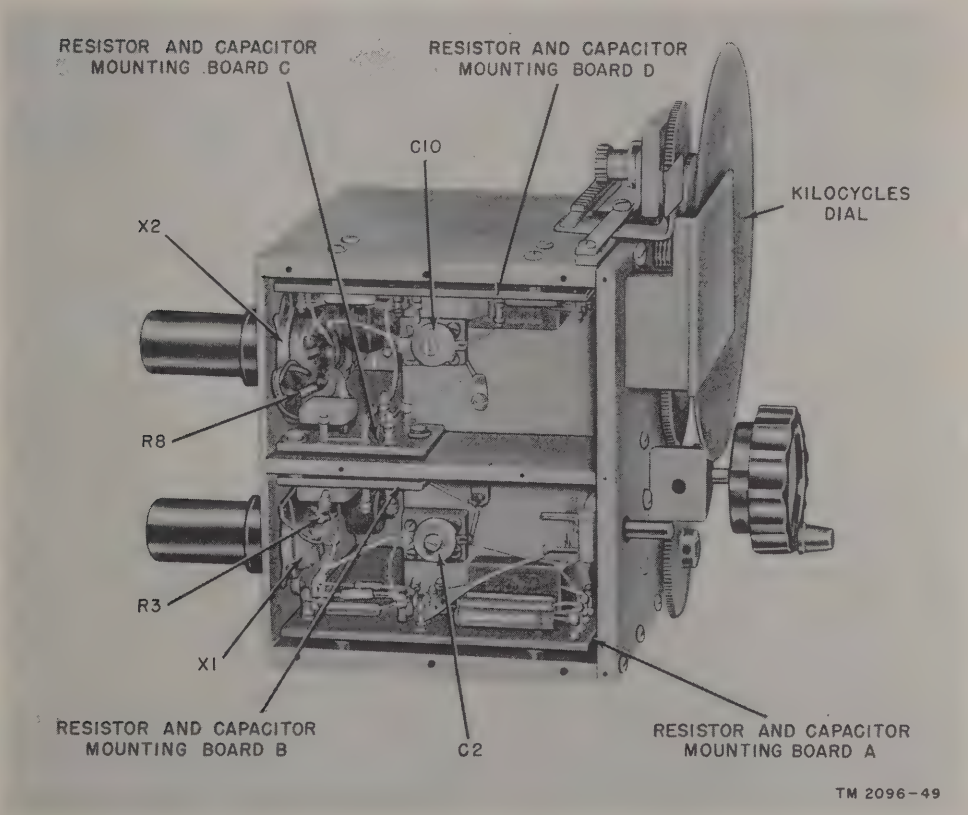

Figure 21. Oscillator assembly, top view, location of parts.

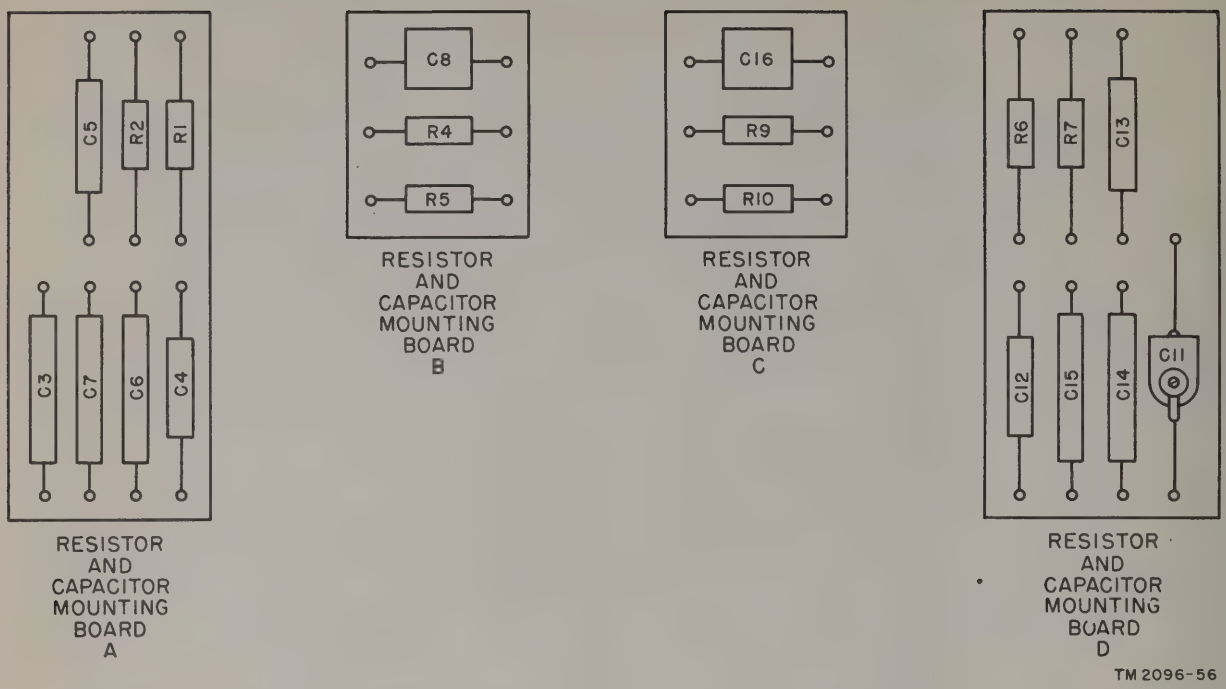

Figure 22. Oscillator assembly, resistor and capacitor mounting boards located on top of unit.

A knowledge of the functioning of the equipment and the theory of operation is necessary for properly applying the techniques of trouble shooting. Detailed functioning of Signal Generator SG-15/PCM is covered in paragraphs 43 through 52. The trouble-shooting chart (par. 66) is intended to provide a step-by-step procedure that can be used as a reference when attempting to locate trouble in the equipment. Consult the following trouble-shooting data when necessary:

a. Complete schematic diagram (fig. 29).

b. Block diagram (fig. 8).

c. Simplified schematic diagrams (figs. 9 through 16).

d. Theory of operation (pars. 43 through 52).

e. Tube socket voltage and resistance diagram (fig. 23).

f. Illustrations showing location of parts (figs. 17 through 22).

g. Wiring diagram (fig. 30).

62. Test Equipment Required for Trouble Shooting

The test equipment listed below is required for trouble shooting Signal Generator SG-15/PCM:

a. Electronic Multimeter ME-6/U. Refer to paragraph 53*b* for a brief description and for testing ranges of this equipment.

b. Frequency Meter FR-67/U. Refer to paragraph 53*b* for a brief description and for testing ranges of this equipment.

c. Multimeter TS-352/U (TM 11-5527).

d. Tube Tester I-177 or I-177-A (TM 11-2627) and Tube Socket Adapter Kit MX-949/U.

63. General Precautions

Certain precautions should be observed when Signal Generator SG-15/PCM is being repaired. Observing these rules during the repair process may save time and future repair of the equipment.

a. Only competent personnel supplied with adequate tools and equipment are authorized to service and repair this equipment. An inexperienced operator attempting to make repairs may damage the equipment to such an extent that major repairs may be necessary rather than the original minor repairs. Careless replacement of parts often makes new faults inevitable.

b. All of the parts of the signal generator, with the exception of the oscillator assembly gears and main tuning capacitor, can be reached and replaced easily. Access is gained by removing the cover and the bottom plate. Always remove the cover in a straight upward movement to avoid damaging the spare tubes on the inside top of the cover.

c. Test tubes before making any repair. Tubes are the most common cause of trouble.

d. When removing and replacing defective parts and circuit elements, be careful not to damage leads or other parts by pulling or pushing them out of the way. Before attempting repairs, make sure that proper tools and test equipment are available.

e. Make a careful record of the connections to each part removed and of the position of each part in the unit. Keep all leads as short as possible. Be sure to use the same ground point as was used in the original wiring. Avoid using more solder than is necessary to make a secure connection. Solder carelessly dropped in the unit may cause short circuits which will create a new fault. It is very important to make well-soldered joints since a poorly soldered joint is one of the most difficult faults to find.

f. Do not replace circuit components in the oscillator assembly. However, the oscillator assembly may be replaced as a unit. Directions for removal and replacement of the oscillator assembly are given in paragraph 71.

64. Power Supply Test

a. Make the resistance measurements indicated for tubes 10 through 13 in the tube socket voltage and resistance diagram (fig. 23). Make any necessary repairs before proceeding.

b. After necessary repairs have been made, or if the resistance readings are normal, apply power to the signal generator (pars. 14 and 15). The pilot lamp should light. If the pilot lamp does not light, check fuse F1 and lamp I-1 (par. 55*a*). If the fuse is defective and a new fuse burns out, do not continue to change fuses but check the power supply circuit (par. 64). If the pilot lamp lights, inspect the signal generator as it warms up for evidence of arcing or crackling or other signs of abnormal operation (par. 56*a*). Try to detect any odors that indicate overheating of parts, insulation, etc.

c. If abnormal indications are present, turn off the power. Locate the cause of the abnormality by checking each component in the circuit in which the abnormality was observed (pars. 45 through 52). Replace any faulty part and correct any trouble before proceeding.

d. If no abnormal indication appears, measure the voltage at the terminals of tubes 13, 12, 11, and 10 in the order given (fig. 23). Correct voltage readings indicate that the power supply circuit is functioning properly. Incorrect readings indicate improper operation of the power supply circuit.

e. After the signal generator has been operating for about 10 or 15 minutes, feel the tubes cautiously to see whether they are warm or hot. No tube should remain cold. If a tube does not warm up, examine the wiring to the tube socket contacts. If there is no wiring trouble, test the tube with a tube tester or by placing it in another signal generator known to be in good operating condition.

65. Operational Test

Operate the signal generator as described in the equipment performance checklist (par. 42). Frequently, the equipment performance test will indicate the general location of the trouble.

66. Trouble-shooting Chart

The trouble-shooting chart is an aid in locating trouble in Signal Generator SG-15/PCM. This chart lists the symptoms that can be observed during operation, the probable cause or causes, and the procedures for correcting the defect. Point-to-point voltage tests can be used

to supplement these procedures. Once the trouble has been localized to a stage or circuit, a tube check or voltage and resistance measurements of the stage or circuit usually should be sufficient to isolate the defective part. Normal voltage and resistance measurements are given in figure 23.

66. Trouble-shooting Chart (contd)

Symptom	Probable cause	Correction
Signal generator inoperative. Pilot lamp and tubes do not light.	Fuse F1 burned out.	Check fuse (par. 55*a*) and replace if necessary.
	Power ON-OFF switch defective.	Check switch (par. 56*a*) and replace if necessary.
	PRIMARY VOLTAGE switch defective.	Check switch (par. 56*a*) and replace if necessary.
No output from signal generator, and no reading on OUTPUT LEVEL meter. Pilot lamp and tubes light.	0- to 40-kc filter open.	Check continuity of 0- to 40-kc filter at terminals 1 and 3 (par. 69). Replace if necessary.
	FINE DBM potentiometer open or defective.	Check potentiometer (par. 56*a*) and replace if necessary.
	One of the following tubes defective: V1, V7, V2, V8, V9, V3, V4, V5, V6, V10, V11, V12, or V13.	Test voltage at pin 8 of tube V12 (fig. 23). If this voltage is abnormal, trouble is indicated in the power supply circuit. Replace tubes V13, V12, V11, and V10, one at a time in the order given, to locate defective tube. If changing tubes does not locate the trouble, return original tubes to sockets and troubleshoot the power supply (fig. 23). If there is no apparent trouble in the power supply, replace tubes V5, V6, V4, V3, V9, V8, V2, V7, and V1, one at a time in the order given, to locate defective tube. If changing tubes does not locate the trouble, return original tubes to sockets and troubleshoot the circuits of these tubes (fig. 23 and pars. 68 and 69). *Do not change tube V2 unless absolutely necessary.* If tube V2 must be replaced, refer to paragraph 75*a*.
No output at OUTPUT terminals and/or jack. Meter reading normal.	OUTPUT terminals and/or jack defective.	Check terminals and jack (par. 56*a*). Repair or replace if necessary.
	COARSE DBM attenuator defective.	Check continuity of attenuator in all positions of control (par. 68). Replace if necessary.
No reading on OUTPUT LEVEL meter. Output of signal generator normal at OUTPUT terminals and jack.	Connections to OUTPUT LEVEL meter loose or defective.	Check meter connections (par. 56*a*) and repair if necessary.
	Potentiometer R44 defective.	Check potentiometer (par. 56*a*) and replace if necessary.
	Meter rectifier CR1, CR2, CR3, or CR4 defective.	Check rectifiers (par. 69) and replace if necessary.
	Resistor R42, R43, or R52 defective.	Check resistors (pars. 56*a* and 68) and replace if necessary.
	OUTPUT LEVEL meter defective.	Check meter (par. 68) and replace if necessary.

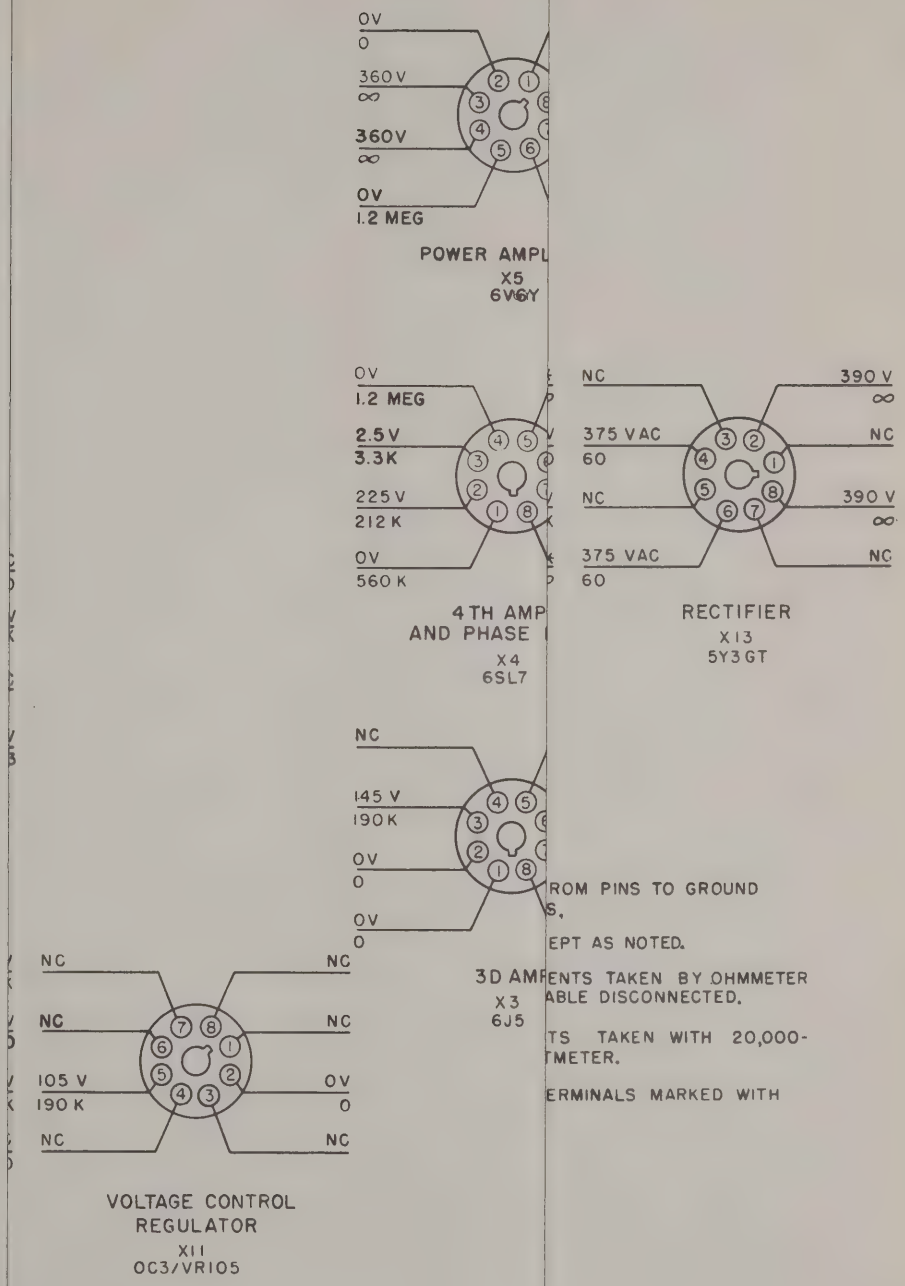

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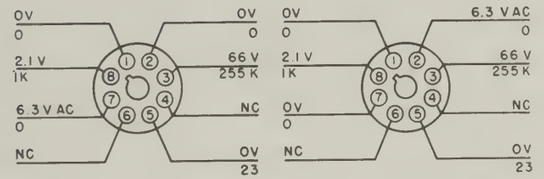
Figure 23. Tube socket voltag

to supplement these procedures. Once the trouble has been localized to a stage or circuit, a tube check or voltage and resistance measurements of the stage or circuit usually should be sufficient to isolate the defective part. Normal voltage and resistance measurements are given in figure 23.

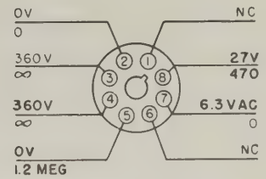
66. Trouble-shooting Chart (contd)

Symptom	Probable cause	Correction
Signal generator inoperative. Pilot lamp and tubes do not light.	Fuse F1 burned out.	Check fuse (par. 55*a*) and replace if necessary.
	Power ON-OFF switch defective.	Check switch (par. 56*a*) and replace if necessary.
	PRIMARY VOLTAGE switch defective.	Check switch (par. 56*a*) and replace if necessary.
No output from signal generator, and no reading on OUTPUT LEVEL meter. Pilot lamp and tubes light.	0- to 40-kc filter open.	Check continuity of 0- to 40-kc filter at terminals 1 and 3 (par. 69). Replace if necessary.
	FINE DBM potentiometer open or defective.	Check potentiometer (par. 56*a*) and replace if necessary.
	One of the following tubes defective: V1, V7, V2, V8, V9, V3, V4, V5, V6, V10, V11, V12, or V13.	Test voltage at pin 8 of tube V12 (fig. 23). If this voltage is abnormal, trouble is indicated in the power supply circuit. Replace tubes V13, V12, V11, and V10, one at a time in the order given, to locate defective tube. If changing tubes does not locate the trouble, return original tubes to sockets and troubleshoot the power supply (fig. 23). If there is no apparent trouble in the power supply, replace tubes V5, V6, V4, V3, V9, V8, V2, V7, and V1, one at a time in the order given, to locate defective tube. If changing tubes does not locate the trouble, return original tubes to sockets and troubleshoot the circuits of these tubes (fig. 23 and pars. 68 and 69). *Do not change tube V2 unless absolutely necessary.* If tube V2 must be replaced, refer to paragraph 75*a*.
No output at OUTPUT terminals and/or jack. Meter reading normal.	OUTPUT terminals and/or jack defective.	Check terminals and jack (par. 56*a*). Repair or replace if necessary.
	COARSE DBM attenuator defective.	Check continuity of attenuator in all positions of control (par. 68). Replace if necessary.
No reading on OUTPUT LEVEL meter. Output of signal generator normal at OUTPUT terminals and jack.	Connections to OUTPUT LEVEL meter loose or defective.	Check meter connections (par. 56*a*) and repair if necessary.
	Potentiometer R44 defective.	Check potentiometer (par. 56*a*) and replace if necessary.
	Meter rectifier CR1, CR2, CR3, or CR4 defective.	Check rectifiers (par. 69) and replace if necessary.
	Resistor R42, R43, or R52 defective.	Check resistors (pars. 56*a* and 68) and replace if necessary.
	OUTPUT LEVEL meter defective.	Check meter (par. 68) and replace if necessary.

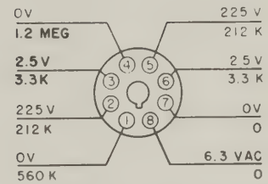


FIXED FREQUENCY OSCILLATOR
X1
6J5

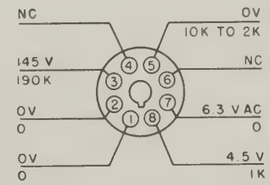
VARIABLE FREQUENCY OSCILLATOR
X2
6J5



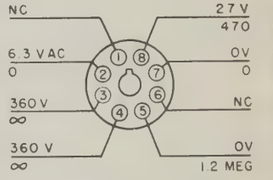
POWER AMPLIFIER
X5
6V6Y



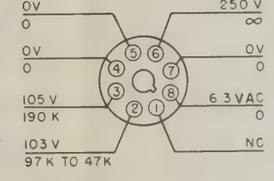
4TH AMPLIFIER AND PHASE INVERTER
X4
6SL7



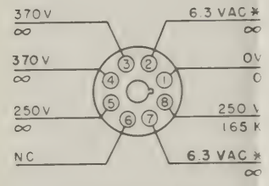
3D AMPLIFIER
X3
6J5



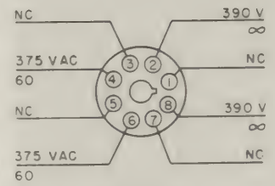
POWER AMPLIFIER
X6
6V6Y



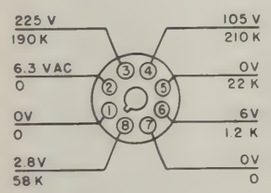
VOLTAGE CONTROL AMPLIFIER
X10
6SQ7



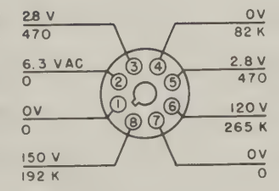
VOLTAGE CONTROL
X12
6L6 GAY



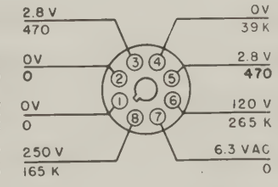
RECTIFIER
X13
5Y3 GT



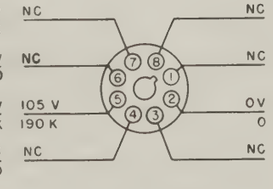
MIXER
X9
6SA7Y



2D AMPLIFIER
X8
6SJ7



1ST AMPLIFIER
X7
6SJ7



VOLTAGE CONTROL REGULATOR
X11
OC3/VR105

NOTES:

1 ALL READINGS TAKEN FROM PINS TO GROUND WITH TUBES IN SOCKETS.

2 ALL READINGS DC, EXCEPT AS NOTED.

3 RESISTANCE MEASUREMENTS TAKEN BY OHMMETER WITH POWER SUPPLY CABLE DISCONNECTED.

4 VOLTAGE MEASUREMENTS TAKEN WITH 20,000-OHMS-PER-VOLT VOLTMETER.

* MEASURED BETWEEN TERMINALS MARKED WITH ASTERISK.

TM 2096-19

Figure 23. Tube socket voltage and resistance diagram.

67. Test Equipment Required for Signal Tracing

The test equipment listed below is required when signal tracing through the various circuits and stages of Signal Generator SG-15/PCM:

a. Electronic Multimeter ME-6/U. Refer to paragraph 53*b* for a brief description and for testing ranges of this test equipment.

b. Multimeter TS-352/U (TM 11-5527).

c. Tube Tester I-177 or I-177-A (TM 11-2627) and Tube Socket Adapter Kit MX-949/U.

68. Circuit Tracing

a. GENERAL. Circuit tracing means to follow the circuit through all the stages of the signal generator from the fixed frequency oscillator and 1st amplifier, the variable frequency oscillator and 2d amplifier, and through the mixer and the 3d and 4th amplifier stages to the output. Circuit tracing is accomplished by taking readings with a vacuum-tube voltmeter at significant points in the various stages and circuits (par. 69). If the signal generator has no output, it is possible to trace the circuit through and determine the point at which the break occurs and to localize the trouble to a particular stage. By trouble shooting the defective stage in conjunction with the information given in the voltage and resistance diagram (fig. 23), it may be possible to determine the defective part.

b. PROCEDURES. (1) Read and record the a-c voltages at the various points in the circuit (par. 69) and compare the readings with the typical voltages.

(2) Check the wiring and soldered connections in each stage during the procedure.

(3) Misalinement of one or more stages of a unit will cause reduced output. Do not change the setting of a fixed adjustment (pars. 74 through 80) unless the trouble has been traced to that adjustment.

(4) When trouble has been localized to a stage, first test the tube if such a test is indicated, then measure the voltages at the tube socket terminals, and, finally, measure the resistance at the tube socket terminals with the *power off*. Refer to the voltage and resistance chart (fig. 23).

(5) Trouble in a circuit or stage may not cause changes in voltage and/or resistance measurements at tube socket terminals. The procedures given here and in paragraph 69 are intended as a guide and should suggest other procedures to the repairman, such as voltage and resistance measurements of individual parts.

(6) Remove only one tube at a time when testing. Test the tube and, if it is not defective, return it to its proper socket before removing another tube.

(7) Each step presupposes the satisfactory completion of all previous steps. Isolate and clear any trouble located before continuing with succeeding steps.

69. Circuit Tracing in Signal Generator SG-15/PCM

a. Put the signal generator into operation in accordance with instructions in paragraphs 14 through 17. Set the signal generator for an output of 0 dbm at 1,000 cps.

b. Using Electronic Multimeter ME-6/U, measure the voltages at the points indicated in the table below, in the order given, and record them. All measurements are from the points indicated to ground unless otherwise specified; other special conditions also are indicated in the table. The values in the typical voltage column are measurements typical of a normally functioning set. These values will vary slightly from one equipment to another, but a voltage differing greatly from the corresponding typical voltage indicates trouble at the point or in the circuit where the measurement is made.

Part or component	Pin or terminal No.	Typical voltage (volts)
V1	8	1.8
V2	8	1.8
V7	4,	.2
	3, 5	.13
	8	12.0
V8	4	.6
	3, 5	.4
	8	10.0
V9	3	3.0
	5	.7
	8	1.3

69. Signal Tracing in Signal Generator SG-15/PCM (contd)

Part or component	Pin or terminal No.	Typical voltage (volts)
Z1	1	3.0
	3	.7
V3	3	2.3
	5	.23
	8	.1
V4	1	2.3
	2	5.5
	3	2.0
	4	.5
	5	4.0
	6	.35
V5	3, 4	30.0
	5	5.0
	8	.6
V6	3, 4	30.0
	5	5.0
	8	.6
T2	4	2.8

69. Signal Tracing in Signal Generator SG-15/PCM (contd)

Part or component	Pin or terminal No.	Typical voltage (volts)
	Across 6 to 8 (terminal 8 grounded)	15.5
E4	Across input terminals (inside grounded)	7.75
L3	1 (input)	35.0
	2 (output)	.8
OUTPUT	E1 to E2 (E2 grounded, no load)	1.55
OUTPUT LEVEL meter rectifier	Junction of CR1 and CR3 to junction of CR2 and CR4	.8

Section III. REPAIRS

70. Replacement of Parts

No special instructions are necessary for the replacement of most parts in Signal Generator SG-15/PCM. All parts can be reached easily for replacement by removing the cover and the plate on the under side of the chassis. When removing wiring from terminals, either by unsoldering or by loosening screw-type terminals, tag each wire to facilitate correct wiring when a new part is installed. Be careful not to damage adjacent parts when removing, installing, and connecting new circuit elements. To remove covered circuit elements, remove the protective cover, the mounting hardware, and then the defective part. Any replacement part should be identical with the original and installed in the same physical position as the part which it replaces. When replacing wiring, be sure that each new piece of wire is the same length as the wire being replaced. If wiring with different color coding is used, mark the change on the wiring diagram (fig. 30).

71. Removing Oscillator Assembly

Do not attempt to disassemble this equipment as calibration accuracy will be lost. Each oscillator assembly is calibrated individually at the time of manufacture, and recalibration should be attempted only by experienced repair personnel equipped with the proper tools and test equipment. However, the oscillator assembly may be replaced as a unit without loss of calibration accuracy. Proceed as follows:

a. Unsolder and tag all connections to the oscillator assembly.

b. Remove the two screws which fasten the slide window to the rack.

c. Remove the FREQUENCY knob and its shaft by loosening the two setscrews in the drive gear behind the panel. Leave the knob on the shaft. Note that there are flats on the shaft where the setscrews seat when the unit is reassembled.

d. Remove the six screws which enter the base of the oscillator assembly from the under side of the chassis. Four of these screws also hold filter Z1 in place but, for the short period of time it takes to replace the oscillator assembly, the filter can be supported by its leads without damage to the equipment.

e. Lift the oscillator assembly straight up. At the same time push the spring on the ZERO BEAT ADJ shaft toward the panel far enough so that the oscilator assembly will clear the shaft.

f. If it is necessary to remove the top and bottom plates of the oscillator assembly, remove the screws at each end of both plates and the screws across the center of the top plate and lift off the plates.

Caution: Do not adjust or disturb the main tuning section, the dial, or the gear train.

g. Replace the oscillator assembly. Aline the mounting holes in the base of the unit with the mounting holes on the chassis, and fasten the oscillator assembly and filter Z1 securely in place from the under side of the chassis. Replace the FREQUENCY knob and its shaft, and replace the screws which fasten the slide window to the rack. Resolder the leads to the correct terminals.

72. Removing Jack

To remove the twin jack mounted on the front panel, proceed as follows:

a. Unsolder and tag all connections to the jack.

b. Remove the two mounting screws and nuts and remove the jack.

c. Replace the jack and tighten the mounting screws securely. Resolder the leads to the correct jack terminals.

Section IV. ALINEMENT PROCEDURES

73. Test Equipment Required for Alinement

The test equipment listed below is required when realining parts and circuits of Signal Generator SG-15/PCM:

a. Electronic Multimeter ME-6/U. Refer to paragraph 53*b* for a brief description and for testing ranges of this unit.

b. Frequency Meter FR-67/U. Refer to paragraph 53*b* for a brief description and for testing ranges of this test equipment.

c. Multimeter TS-352/U (TM 11-5527).

d. Five 600-ohm precision resistors ±.1 percent.

74. Alinement of Fixed Frequency Oscillator

The fixed frequency oscillator is adjusted to approximately 100 kc at the time of manufacture and ordinarily will not require realinement. Its exact frequency when in zero beat with the variable frequency oscilator, at room temperature and with the KILOCYCLES dial at 0, is stamped on the oscillator housing.

Caution: Do not realine the fixed frequency unless it is absolutely necessary. Attempted realinement may result in loss of KILOCYCLES dial calibration. However, replacement of oscillator coil L1, capacitor C1 or C2, or other major circuit elements may make realinement of the oscillator necessary.

a. AFTER REPLACING CIRCUIT ELEMENT. After a circuit element in the fixed frequency oscillator assembly has been replaced, turn the signal generator on and allow it to warm up for 10 to 15 minutes with the oscillator assembly cover in place. Set the FREQUENCY control for a 0 reading on the KILOCYCLES dial, and set the ZERO BEAT ADJ control for zero beat on the OUTPUT LEVEL meter (par. 16*c*). If the zero-beat point cannot be reached, proceed as follows:

(1) With the oscillator assembly cover removed and the KILOCYCLES dial on 0, set ZERO BEAT ADJ capacitor C1 to the midpoint of its range.

(2) Adjust trimmer capacitor C2 for zero beat. Note the reading on the OUTPUT LEVEL meter.

(3) Replace the oscillator assembly cover and adjust the ZERO BEAT ADJ control for zero beat.

b. AFTER REPLACING TUBE V1. If tube V1 is replaced, readjust the ZERO BEAT ADJ control for zero beat.

c. FINAL TEST. Using Frequency Meter FR-67/U, check to see that the frequency of the fixed frequency oscillator at zero beat is the same as the frequency stamped on the housing. Measure this frequency at pin 5 of tube V9 (fig. 23).

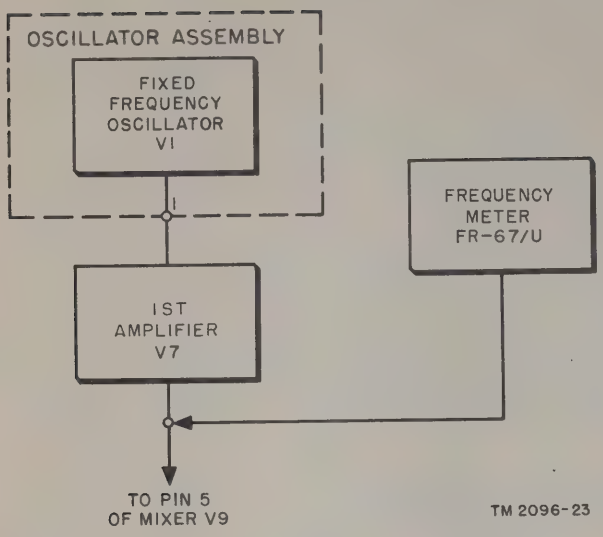


Figure 24. Fixed frequency oscillator, alinement and final test circuit.

75. Alinement of Variable Frequency Oscillator

The variable frequency oscillator is alined at the time of manufacture and ordinarily will not require any adjustment. Its exact frequency, at room temperature and with the KILOCYCLES dial at 0, is stamped on the outside of the oscillator assembly housing.

Caution: *All* adjustments on the variable frequency oscillator affect the calibration of the KILOCYCLES dial. Do not attempt any adjustments unless it is absolutely necessary. *Do not* vary the adjustment of temperature compensating capacitor C11 at any time.

a. After Replacing Tube V2. If tube V2 is replaced, normally it will be necessary to readjust the ZERO BEAT ADJ control for zero beat (par. 74*a*). However, there will be a minor loss in calibration accuracy. Do not replace tube V2 unless it is absolutely necessary.

b. After Replacing Resistor or Capacitor. After any resistor or capacitor in the variable frequency oscillator has been replaced, an adjustment of capacitor C10 is necessary. If capacitor C9 is replaced, however, there also will be a loss of calibration accuracy of the KILOCYCLES dial. Do not replace capacitor C9 unless it is absolutely necessary. After replacing a capacitor or resistor, proceed as follows:

(1) With Frequency Meter FR-67/U connected to pin 5 of tube V9 (fig. 24), set the fixed frequency oscillator to the zero-beat frequency stamped on the oscillator housing (par. 74*a*). Make this adjustment of the ZERO BEAT ADJ control with the oscillator assembly cover in place.

(2) Set the FREQUENCY control so that the KILOCYCLES dial indicates 0.

(3) Adjust trimmer capacitor C10 so that the variable frequency oscilator is at zero beat with the fixed frequency oscillator when the oscillator assembly cover is in place.

(4) Using Frequency Meter FR-67/U, measure the frequency of the variable frequency oscillator at zero beat at pin 8 of tube V9 (fig. 25).

(5) Advance the FREQUENCY control until the KILOCYCLES dial reads 35 kc. With the oscillator assembly cover in place, check the frequency at OUTPUT terminals E1 and E2 with Frequency Meter FR-67/U.

c. After Replacing Coil L1. When coil L1 is replaced, adjustment of the capacitors C2 and C10 is necessary. Do not replace coil L1 unless it is absolutely necessary because it may not be possible to obtain complete calibration accuracy. When coil L1 has been replaced, however, use the following alinement procedure:

(1) With the oscillator assembly cover in place, set the FREQUENCY control for 0 on the KILOCYCLES dial.

(2) In the fixed frequency oscillator, adjust trimmer capacitor C2 for zero beat. Check with the oscillator assembly cover in place.

(3) Advance the FREQUENCY control until the KILOCYCLES dial reads 35 kc.

(4) Adjust trimmer capacitor C10 in the variable frequency oscillator until the output frequency measures 35 kc with the oscillator assembly cover in place.

(5) Reset the FREQUENCY control until the KILOCYCLES dial is on 0.

(6) Restore zero beat by adjusting ZERO BEAT ADJ capacitor C1. Check with the oscillator assembly cover in place.

(7) Repeat the instructions in subparagraphs (3) through (6) above until no further adjustment is required.

(8) Calibration of the KILOCYCLES dial may be slightly inaccurate at some intermediate points between 0 and 35 kc. This is inevitable when a new coil L2 has been restored. However, the chance of error will be less if the new coil L2 is identical with the old.

(9) The zero-beat frequency stamped on the oscillator housing is no longer applicable. Using Frequency Meter FR-67/U, measure the zero-beat frequencies at pin 5 of tube V9 (fig. 24) for the fixed frequency oscillator and at pin 8 of tube V9 (fig. 25) for the variable frequency oscillator. Record these frequencies on the oscillator housing as the new zero-beat frequencies.

76. Mechanical Alinement of Kilocycles Dial Calibration

Do not disturb the mechanical alinement between the KILOCYCLES dial and the shaft of FREQUENCY capacitor C9 unless it is absolutely necessary. It is very difficult to restore frequency calibration accuracy once this alinement has been disturbed. If the alinement of the KILOCYCLES dial is known to be in error, however, use the following procedure in attempting to restore it:

a. Remove the oscillator assembly from the signal generator (par. 71).

b. Remove the bottom cover from the oscillator assembly by removing the four flathead screws.

c. Set capacitor C9 so that the long edges of its rotor plates are meshed and flush with the edges of the stator plates. Use the end of a straightedge to check that the edges of these plates are flush.

d. With capacitor C9 set as in subparagraph *c* above, the short straight line (not the dot) marked on the outer edge of the dial should be flush with the lower edge of the angle bracket which supports the FREQUENCY knob shaft. If this relationship is not true, loosen the setscrews in the small gear on the shaft of capacitor C9 and, while holding capacitor C9 stationary, slip the dial clockwise or counterclockwise, as required. Tighten the setscrews.

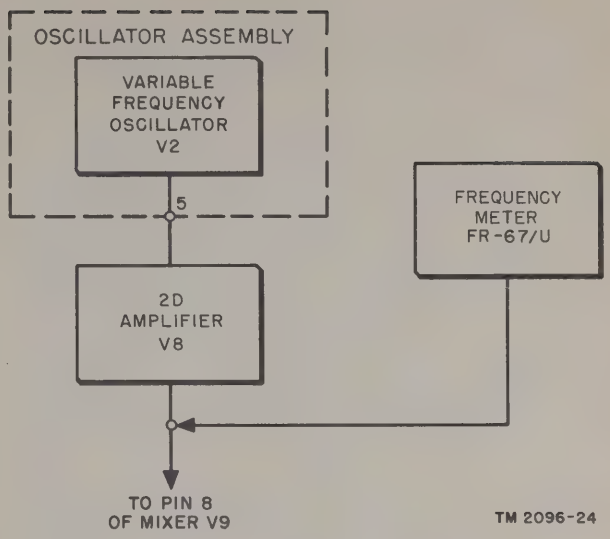


Figure 25. Variable frequency oscillator, alinement and final test circuit.

e. With capacitor C9 adjusted as in subparagraphs *c* and *d* above, the top of the bracket which carries the dial window shutter should be ⅛ inch below the bottom edge of the hairline indicator mounting block. If it is not, loosen the setscrews in the small gear which drives the rack. Slip the rack up or down, as required, while holding the other gears stationary.

f. With capacitor C9 adjusted as in subparagraphs *c* and *d* above, the stop mechanism should be at the end of its rotation in a counterclockwise direction as viewed from the front of the oscillator assembly. If it is not, loosen the setscrews in the collar or the inside end of the stop mechanism shaft and rotate the collar counterclockwise as far as it will go. Hold all gears stationary while making this adjustment. Tighten the setscrews.

g. Check to see that the flush plates (subpar. *c* above), the dial line mark (subpar. *d* above), the shutter bracket (subpar. *e* above), and the stop mechanism (subpar. *f* above) are set as required. If they are, seal all setscrews with glyptal or paint.

h. Replace the bottom cover of the oscillator assembly.

i. Replace the oscillator assembly in the signal generator.

j. If the oscillator unit is still not on calibration when alinement procedures are completed, draw a calibration curve or chart, using the numbers on the dial and the new zero beat frequencies.

77. Alinement of Transformer T1

Transformer T1 (figs. 11 and 19) is adjusted at the time of manufacture. Ordinarily, realinement should be necessary only if the transformer tuning slugs lose their adjustment after long periods of operation or after replacement of the transformer itself. Check the adjustment of the tuning slugs if the signal generator has an abnormally low output.

a. Loosen the locking bushings of the tuning slugs, top and bottom, one-half turn.

b. Set the FINE DBM control to give any convenient output reading, such as +1 db, on the OUTPUT LEVEL meter.

c. Using a suitable screw driver and a pair of pliers, adjust the tuning slugs of the transformer for maximum output on the OUTPUT LEVEL meter. Use the setting of the FINE DBM control (subpar. *b* above) as a reference level.

d. Tighten the locking bushings of the transformer tuning slugs.

78. Alinement of Meter-adjusting Potentiometer R44

Potentiometer R44 (figs. 14 and 17) is used to calibrate the metering circuit. This potentiometer is adjusted at the time of manufacture, but changes in the value of resistor R42, R43, or R52, meter M1, rectifier CR1, CR2, CR3, or CR4, or potentiometer R44 itself, as well as the replacement of any of these parts, will make realinement of the potentiometer necessary.

a. Set COARSE DBM control E4 to —50.

b. Place an output meter, such as Electronic Multimeter ME-6/U, across the input terminals of attenuator E4.

c. Adjust the FINE DBM control to give a reading of 7.74 volts on the output meter.

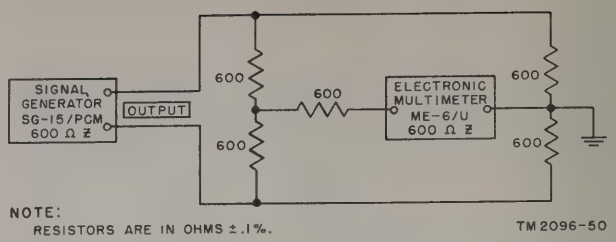


Figure 26. Adjusting longitudinal output, test circuit.

d. Set potentiometer R44 so that OUTPUT LEVEL meter M1 reads 0 db.

79. Alinement of B+ ADJ Potentiometer R50

B+ ADJ potentiometer R50 (figs. 16 and 17) is used to adjust the operating level of the regulated +250-volt supply. This adjustment should be made whenever tube V10, V11, or V12 is replaced.

a. Connect Multimeter TS-352/U between pin 8 of tube V12 and ground.

b. Adjust potentiometer R50 for a reading of +250 volts.

80. Alinement of Capacitor C35

Capacitor C35 (fig. 17) is a trimmer capacitor which is used to minimize longitudinal output—that is, to compensate for any difference in capacitance to ground which may exist between the two branches of the output circuit of transformer T2.

a. Operate the signal generator in accordance with instructions in paragraphs 14 through 17. When the equipment has warmed up for 10 to 15 minutes, adjust the signal generator for an output of +20 dbm at 35,000 cps.

b. Using Electronic Multimeter ME-6/U and the five 600-ohm precision resistors, connect the signal generator into the test circuit shown in figure 26.

c. Adjust capacitor C35 for a minimum reading on Electronic Multimeter ME-6/U. This reading must be less than .0245-volt ac.

Section V. FINAL TESTING

81. General

This section is intended as a guide to be used in determining whether a repaired Signal Generator SG-15/PCM is functioning properly. The tests given in paragraphs 83 and 84 should be performed by experienced maintenance personnel provided with adequate test equipment. If the minimum test requirements are met by the signal generator, the unit is capable of performance equal to that of new equipment.

Caution: High voltage is used in the signal generator. Avoid direct contact with any part of the chassis when power is applied. Death or serious injury may result from failure to observe safety precautions.

82. Test Equipment Required for Final Testing

The test equipment listed below is required when testing a repaired Signal Generator SG-15/PCM:

a. Decibel Meter ME-22/PCM. Refer to the instruction book covering the decibel meter.

b. Electronic Multimeter ME-6/U. Refer to paragraph 53*b* for a brief description and for testing ranges of this test equipment.

c. Frequency Meter FR-67/U. Refer to paragraph 53*b* for a brief description and for testing ranges of this equipment.

d. Multimeter TS-352/U (TM 11-5527).

83. Final Testing of Individual Stages and Circuits

The following table lists the stages and circuits which require individual testing, the test equipment necessary for each test, the requirements which must be met, and what to do if the requirements are not met. Before making final tests, proceed as follows:

a. Remove the cover and the bottom plate from the signal generator.

b. Start and calibrate the signal generator in accordance with instructions in paragraphs 14 through 16.

c. Set B+ ADJ potentiometer R50 for an output of +250 volts regulated dc (par. 79).

Stage or circuit	Test equipment	Requirements	What to do
Fixed frequency oscillator (tube V1).	Frequency Meter FR-67/U.	100-kc output with ZERO BEAT ADJ capacitor C1 not at end of range.	Reset ZERO BEAT ADJ control and/or capacitor C2 (par. 74).
Variable frequency oscillator (tube V2).	Frequency Meter FR-67/U.	Approximately 100.2- to 135-kc output, corresponding to KILOCYCLES dial setting of 200 to 35,000 cps. Accuracy — ±10 cps from .2 to 1 kc, ±20 cps from 1 to 2 kc, ±50 cps from 2 to 35 kc.	Reset KILOCYCLES dial and/or capacitor C10 (pars. 75 and 76). *Note.* Do not measure the 100- to 135-kc frequency for accuracy — measure the beat frequency instead.
Transformer T1.	FINE DBM control.	Tuned for maximum output on OUTPUT LEVEL meter.	Readjust tuning slugs of transformer T1 (par. 77).
Potentiometer R44.	Electronic Multimeter ME-6/U.	OUTPUT LEVEL meter reads 0 db with FINE DBM control set for +20 dbm and multimeter across input terminals of attenuator E4.	Reset potentiometer R44. (par. 78).
Trimmer capacitor C35.	Electronic Multimeter ME-6/U.	Adjusted for minimum output with signal generator connected in test circuit (fig. 26).	Readjust capacitor C35 (par. 80) or replace if necessary.
B+ ADJ potentiometer R50.	Multimeter TS-352/U.	+250 volts dc between pin 8 of tube V12 and ground.	Readjust potentiometer R50 for meter reading of +250 volts dc (par. 79).

84. Final Testing of Signal Generator SG-15/PCM

a. PREPARATORY. (1) Replace the cover and the bottom plate of the signal generator.

(2) Place the signal generator in its carrying case as for routine operation.

(3) Start and calibrate the signal generator in accordance with instructions in paragraphs 14 through 16.

b. POWER OUTPUT TEST. (1) Set the COARSE DBM control to ZERO OUTPUT.

(2) Operate the decibel meter in accordance with directions in the instruction book covering the decibel meter. Set the INPUT IMPEDANCE switch to 600 OHM. When the decibel meter is adjusted properly, connect it across the OUTPUT terminals of the signal generator.

(3) On the signal generator, adjust the FREQUENCY control until the KILOCYCLES dial reads 35 kc.

(4) Set the COARSE DBM control to —40. Operate the FINE DBM control through the range of the OUTPUT LEVEL meter, from —4 to +6 db. The meter on the decibel meter should indicate a corresponding range, from —44 to —34 dbm.

(5) With the FINE DBM control adjusted for +6 db on the OUTPUT LEVEL meter, operate the COARSE DBM control to —30, —20, —10, 0, +10, and +20 in that order. For the corresponding settings of the COARSE DBM control, the meter on the decibel meter should read —24, —14, —4, +6, +16, and +26 dbm.

(6) Disconnect the decibel meter. Do not disturb the settings of the signal generator controls.

Note. The output of the signal generator is equal to the reading of the OUTPUT LEVEL meter plus the setting of the COARSE DBM control.

c. FREQUENCY RANGE TEST. At the conclusion of the power output test (subpar. *b* above), the controls of the signal generator are set properly for the frequency range test. The FREQUENCY control is set for a reading of 35 kc on the KILOCYCLES dial, the FINE DBM control is adjusted for a reading of +6 db on the OUTPUT LEVEL meter, and the COARSE DBM control is set at +20.

(1) Connect Frequency Meter FR-67/U to the OUTPUT terminals of the signal generator. The test meter should indicate a frequency of 35 kc ±50 cycles.

(2) Set the FREQUENCY control for a reading of 5 kc on the KILOCYCLES dial. The test meter should indicate a frequency of 5 kc ±50 cycles.

(3) Set the FREQUENCY control for a reading of 1,500 cycles on the KILOCYCLES dial. The test meter should indicate a frequency of 1,500 cycles ±20 cycles.

(4) Set the FREQUENCY control for a reading of 200 cycles on the KILOCYCLES dial. The test meter should indicate a frequency of 200 cycles ±10 cycles.

d. OPERATIONAL TEST. Operate the equipment in accordance with the procedure given in the equipment performance checklist (par. 42).

Section VI. REFINISHING

85. General

Check the appearance and condition of the finish of all metal surfaces. The finish should show no decided wear, and no bare metal should be exposed because of chipping or scratches on the surface. Refinish surfaces where the finish has been removed completely or worn through. Retouch such surfaces if the bare parts are restricted to small areas, but refinish the entire surface if the bare or damaged areas are large. Discolored, spotted, stained, or faded surfaces are permissible if the original finish is intact.

86. Refinishing Procedures

After sanding or scratch-brushing, refinish affected surfaces to match the original finish. Apply one coat of lacquer to parts which have a bright metal finish. Apply one coat of matching enamel or paint to painted surfaces. Do not apply lacquer to contact parts of jacks, switches, or potentiometers or to other surfaces which might affect the mechanical or electrical functioning of the equipment.

87. Preservative Application

After the unit has been refinished completely, moistureproof and fungiproof the equipment according to instructions in paragraph 35.

CHAPTER 7

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

Note. The circumstances involved in shipment and storage vary and, therefore, no definite procedure for repacking can be given. The following instructions are recommended as a guide for preparing Signal Generator SG-15/PCM for transportation and storage.

88. Removing from Service

a. Set the power ON-OFF switch to the OFF position.

b. Disconnect the power cable from the power source.

c. Disconnect the output of the signal generator, either at the OUTPUT terminals or the OUTPUT jack, whichever is used.

d. Disconnect the ground lead from the GND terminal.

89. Disassembly

Signal Generator SG-15/PCM is portable and, and, ordinarily, no special disassembly is required. If the signal generator is rack mounted, however, remove the mounting screws from the slots at the sides of the front panel and dismount the signal generator.

90. Repackaging

Note. As far as possible, use the original packaging materials which were saved at the time the equipment was unpacked.

a. Place the switchboard patching cords in the cover of the carrying case.

b. Block and brace in place all delicate components mounted on the chassis with cells and/or pads fabricated of corrugated fiberboard. This will help to reduce shearing stress on mountings and prevent movement or shearing of parts.

c. Place and secure the chassis on the shock-mounted rack in the carrying case. Whenever possible, place a dehydrating agent, such as silica gel, inside the case. Close the lid of the case and secure the fastenings.

d. Cushion all sharp projecting edges, handles, and fastenings by covering the case with a ½-inch thickness of neutral cellulose wadding. Secure the cushioning with pressure-sensitive tape.

e. Cushion the cased signal generator on all surfaces with cells and/or pads fabricated of corrugated fiberboard. This will absorb the shock of impact normally encountered in handling and during transit.

f. Place the cushioned signal generator in a close-fitting, regular slotted style, corrugated fiberboard box. Seal the entire closure with gummed paper tape. Blunt all corners of the box.

g. Place the boxed signal generator in a moisture-vaporproof barrier. Extract all air and heat-seal the barrier.

h. Place the moisture-vaporproofed signal generator in a second close-fitting, regular slotted style, corrugated fiberboard box. Seal the entire closure with water-resistant tape or adhesive.

i. Overwrap the boxed signal generator with waterproof barrier material. Completely seal the package at all joints, seams, and closures with adhesive or another suitable seal.

91. Packing

Place the signal generator, packaged as described in paragraph 90, in a nailed wooden box which is lined on all interior surfaces with a 2-inch thickness of excelsior. If excelsior is not available, use pads of corrugated fiberboard. Fill all voids in the box to prevent shifting of the contents.

Section II. DEMOLITION TO PREVENT ENEMY USE

92. Methods of Demolition

a. SMASH. Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.

b. CUT. Use axes, handaxes, machetes.

c. BURN. Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

d. EXPLODE. Use firearms, grenades, TNT.

e. DISPOSE. Burn in slit trenches, fox holes, other holes. Throw in streams. Scatter.

Note. Use anything immediately available for destruction of this equipment.

93. Destruction of Components

When ordered by your commander, destroy all equipment to prevent its being used or salvaged by the enemy.

a. Smash (par. 92*a*) switches, controls, tubes, jack, binding posts, resistors, capacitors, transformers, tube sockets, meter, oscillator assemblies, cord plugs, chassis, and case.

b. Cut (par. 92*b*) power cord, switchboard patching cords, and wiring.

c. Burn (par. 92*c*) Signal Corps forms, office records, and technical manuals.

d. Bury or scatter (par. 92*e*) all of the above parts after they have been rendered useless.

DESTROY EVERYTHING

APPENDIX I

REFERENCES

Note. For availability of items listed, check SR 310-20-3, SR 310-20-4, and SR 310-20-5. Check Department of Army Supply Catalog SIG 1 for Signal Corps Supply Catalog pamphlets.

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1. Regulations

AR 380-5	Military Security (Safeguarding Military Information)
AR 750-5	Maintenance of Supplies and Equipment (Maintenance Responsibilities and Shop Operation.

2. Supply Bulletins

SB 11-47	Preparation and Submission of Requisitions for Signal Corps Supplies.
SB 11-76	Signal Corps Kit and Materials for Moisture- and Fungi-Resistant Treatment.
SB 11-100	Serviceability Standards for Signal Equipment in Hands of Troops.

3. Test Equipment

TM 11-2627	Tube Tester I-177 and I-177-A.
TM 11-5527	Multimeter TS-352/U.

4. Painting and Preserving

TB SIG 13	Moistureproofing and Fungiproofing Signal Corps Equipment.
TM 9-2851	Painting Instructions for Field Use.

5. Decontamination and Demolition

TM 3-220	Decontamination.
FM 5-25	Explosives and Demolitions.

6. Other Publications

FM 24-5	Signal Communications.
FM 72-20	Jungle Warfare.
SR 310-20-3	Index of Training Publications.
SR 310-20-4	Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, Modification Work Orders, Tables of Organization and Equipment, Reduction Tables, Tables of Allowances, Tables of Organization, and Tables of Equipment.
SR 310-20-5	Index of Administrative Publications.
SR 700-45-5	Unsatisfactory Equipment Reports (Reports Control Symbol CSGLD-247).

SR 745-45-5 NAV DEPT SERIAL 85P00 AFR 71-4	Report of Damaged or Improper Shipment (Reports Control Symbols CSGLD-66 (Army), SandA-70-6 (Navy), and AF-MC-U2 (Air Force)).
TB SIG 25	Preventive Maintenance of Power Cords
TB SIG 66	Winter Maintenance of Signal Equipment.
TB SIG 72	Tropical Maintenance of Ground Signal Equipment.
TB SIG 75	Desert Maintenance of Ground Signal Equipment.
TB SIG 123	Preventive Maintenance Practices for Ground Signal Equipment.
TB SIG 219	Operation of Signal Equipment at Low Temperatures.
TM 11-453	Shop Work.
TM 11-462	Signal Corps Tactical Communication Reference Data.
TM 11-486	Electrical Communication Systems Engineering.
TM 11-676	Grounding Procedure and Protective Devices.

APPENDIX II
IDENTIFICATION TABLES OF PARTS

Note. The following are identification tables of parts for Test Set TS-140/PCM (Sig C stock No. 3F4325-140) and Signal Generator SG-15/PCM (Sig C stock No. 3F3901.1-15). The fact that a part is listed in these tables is not sufficient basis for requisitioning the item. Requisitions must cite an authorized basis, such as a specific T/O&E, T/A, SIG 6, SIG 7&8, list of allowances of expendable material, or another authorized supply basis. The Department of the Army Supply Catalog applicable to Test Set TS-140/PCM is SIG 6-TS-140/PCM, and the Department of the Army Supply Catalog applicable to Signal Generator SG-15/PCM is SIG 7&8-SG-15/PCM. For an index of available supply catalogs in the Signal portion of the Department of the Army Supply Catalog, see the latest issue of SIG 1, Introduction and Index.

1. Identification Table of Parts for Test Set TS-140/PCM

Ref Symbol	Name of part and description	Function of part	Signal Corps stock No.
	Decibel Meter ME-22/PCM[a].	Used for making transmission measurements of carrier equipment and wire and cable lines.	3F3307.11-1
	Signal Generator SG-15/PCM. (See par. 2, app II for parts.)	Provides a source of testing power for transmission measurements of carrier equipment and wire and cable lines.	3F3901.1-15

[a]The identification table of parts for Decibel Meter ME-22/PCM is contained in the instruction book for Decibel Meter ME-22/PCM.

2. Identification Table of Parts for Signal Generator SG-15/PCM

Ref Symbol	Name of part and description	Function of part	Signal Corps stock No.
E4	ATTENUATOR, variable: balanced H type; WW; impedance 600 ohms ±2%, 200 to 35,000 cps; 8-step attenuation, 10 db per step.	COARSE DBM control. Provides eight steps of attenuation of 10 db per step plus a ZERO OUTPUT position.	2Z394.84
W1	CABLE ASSEMBLY, power: type SJ; two #18 AWG stranded copper cond; 600 v working; 7½′ lg excluding term.	Power cable. For connecting signal generator to a-c source.	1B818.14
C5, C13	CAPACITOR, fixed: ceramic; 120 uuf ±1%; 500 vdcw; JAN type CC35CF121F.	C5 — Part of the tank circuit associated with fixed frequency oscillator tube V1. C13 — Part of the tank circuit associated with variable frequency oscillator tube V2.	3D9120-21
C3	CAPACITOR, fixed: ceramic; 200 uuf ±5%; 500 vdcw; JAN type CC45CF221J.	Part of the tank circuit associated with fixed frequency oscillator tube V1.	3D9220-30

2. Identification Table of Parts for Signal Generator SG-15/PCM (contd)

Ref Symbol	Name of part and description	Function of part	Signal Corps stock No.
C6, C7, C14, C15	CAPACITOR, fixed: ceramic; 300 uuf ±10%; 500 vdcw; JAN type CC45CF-301K.	C6, C7 — Part of the tank circuit associated with fixed frequency oscillator tube V1. C14, C15 — Part of the tank circuit associated with variable frequency oscillator tube V2.	3D9300-67
C22, C23	CAPACITOR, fixed: mica; 1000 uuf ±10%; 300 vdcw; JAN type CM30D102J.	With resistors R25, R26, and R27, form output impedance network.	
C8, C16, C32	CAPACITOR, fixed: mica; 2200 uuf ±10%; 500 vdcw; JAN CM30E222K.	C8 — Couples the output from the cathode of tube V1 to a voltage divider consisting of resistors R4 and R5. C16 — Couples the output of tube V2 to a voltage-dividing network consisting of resistors R9 and R10. C32 — Immediately applies any voltage change across the voltage divider consisting of resistors R49 and R51 and potentiometer R50 to the grid of voltage control amplifier tube V10.	3K3022251
C4, C12, C18, C19, C20, C21	CAPACITOR, fixed: paper; single sect.; 30,000 uuf ±20%; 600 vdcw; JAN type CN43A303M.	C4 — Plate bypass capacitor of tube V1. Serves as an r-f connection from the plate of tube V1 to ground and to the ground end of the tank circuit associated with tube V1. C12 — Plate bypass capacitor of tube V2. C18 — Couples the output of 3d amplifier tube V3 to the grid of 4th amplifier tube V4A. C19 — Applies the output from the plate of tube V4A to the grid of tube V5 and to resistors R21 and R22 in series. With resistors R21 and R22, forms an a-c voltage divider of the output of tube V4A. C20 — Couples the signal at the junction of voltage-dividing resistors R21 and R22 to the grid of tube V4B. C21 — With resistors R22 and R23, forms an a-c voltage divider of the output of tube V4B.	3DA30-80

2. Identification Table of Parts for Signal Generator SG-15/PCM (contd)

Ref Symbol	Name of part and description	Function of part	Signal Corps stock No.
C17	CAPACITOR, fixed: paper; single sect.; 250,000 uuf +20% —10%; 600 vdcw; JAN type CP53B1EF254V.	Couples the output of the plate circuit of tube V9 to filter Z1.	3DA250-380
C24, C27	CAPACITOR, fixed: paper; 2 sect.; 250,000 uuf ±15% ea sect.; 600 vdcw; JAN type CP61B6EF254L.	C24A — Screen bypass capacitor of tube V7. C24B — Screen bypass capacitor of tube V8. C27A — Serves as the r-f ground return for voltage-dividing resistors R35 and R36 and, with resistor R37, filters d-c bias voltage for grid 3 of tube V9. C27B — Screen bypass capacitor of tube V9.	3DA250-563
C26	CAPACITOR, fixed: mica; .01 uf; JAN type CM35D103K.	Couples the output of tube V8 to grid 3 of mixer tube V9.	3K3510341
C31	CAPACITOR, fixed: paper; 2 sect.; .25 uf ea sect.; JAN type CP53B4FF254V.	C31A — With resistor R45, forms a filter network for tube V1. Also decouples the plate voltage of tube V1 from the B+ supply. C31B — With resistor R46, forms a filter network for tube V2. Also decouples the plate voltage of tube V2 from the B+ supply.	
C28	CAPACITOR, fixed: paper; single sect.; 1 uf +20% —10%; 100 vdcw; JAN type CP55B1EB105V.	Cathode bypass capacitor of tube V9.	3DB1-346
C25, C34	CAPACITOR, fixed: paper; single sect.; 4 uf +20% —10%; 600 vdcw; JAN type CP70E1EF405V.	C25 — Filters the output voltage of tube V11. C34 — With choke coil L3 and capacitor C33, forms a filter network for rectifier tube V13. Reduces the ripple content in the pulsating d-c output of the rectifier.	3DB4-279
C33	CAPACITOR, fixed: paper; 8 uf; JAN type CP70B1FF805V.	With capacitor C34 and choke coil L1, forms a filter network for the output of rectifier tube V13. Reduces the ripple content in the pulsating d-c output of the rectifier.	
C1	CAPACITOR, variable: air; plate meshing type; single sect.; 3-10 uuf.	ZERO BEAT ADJ control, used to obtain zero beat between the fixed and variable oscillator tubes V1 and V2. Part of the tank circuit associated with tube V1.	
C11	CAPACITOR, variable: ceramic; 4-30 uuf.	Temperature-compensating capacitor adjusted to keep the drift of the output frequency of the signal generator within limits.	

2. Identification Table of Parts for Signal Generator SG-15/PCM (contd)

Ref Symbol	Name of part and description	Function of part	Signal Corps stock No.
C2, C10	CAPACITOR, variable: ceramic; 4.5-25 uuf; JAN type CV11A250.	C2 — Tuning capacitor for tank circuit associated with fixed frequency oscillator tube V1. This adjustment is made at the time of manufacture. C10 — Part of tank circuit associated with variable frequency oscillator tube V2. With capacitor C9, limits the range of tube V2. This adjustment is made at the time of manufacture.	3D9025V-82
C35	CAPACITOR, variable: ceramic; 7-45 uuf; JAN type CV11C450.	Adjusts the output impedance balance of transformer T2. This adjustment is made at the time of manufacture.	
C9	CAPACITOR, variable: air; plate meshing type; single sect.; 25-220 uuf.	FREQUENCY control. The main tuning control of variable frequency oscillator V2.	3D9220V-14
L1, L2	COIL, RF: oscillator; single pi, universal wound; unshielded; 7.2 uh at 1000 cps, 28 ohms resistance max.	L1 — Part of the tank circuit associated with fixed frequency oscillator tube V1. L2 — Part of the tank circuit associated with variable frequency oscillator tube V2.	3C1081-29B
	CONNECTOR, plug: 2 male flat cont; straight type.	Power cord plug.	6Z1727
CR1, CR2, CR3, CR4	CRYSTAL UNIT, rectifying: germanium diode; JAN type 1N69.	Form a full-wave bridge rectifier circuit which rectifies the output signal of the generator and applies it to meter M1.	
	DIAL: aluminum disk.		
Z1	FILTER, low pass: 40,000 cps cutoff; 10,000 ohms input and 10,000 ohms output impedance; rect metal case.	Zero- to 40-kc filter. Passes the beat frequency and rejects undesired frequency present in the mixer output.	2Z4376.36
F1	FUSE, cartridge: 2 amp; 250 v; glass body.	Overload protection.	3Z2602.29
	GEAR: rack, notched bar; brass; entire length toothed; 3/16″ x 3/16″ cross sect. x 5¼″ lg.	To carry dial window.	2Z4898-1213
	GEAR: spur; brass; 18 straight teeth; .625″ OD x .187″ thk; .251″ bore.	Rack driving.	2Z4878-1191
	GEAR: spur; brass; 32 straight teeth; .708″ OD x ⅛″ thk; .250″ bore.	Oscillator tuning.	2Z4878-1190
	GEAR: spur; brass; 102 straight teeth; 2.167″ OD x ⅛″ thk; .251″ bore.	To drive stop assembly.	2Z4878-1192
	GEAR ASSEMBLY: c/o spur gear soldered on end of ¼″ dia shaft; stainless steel shaft, brass gear; 96 straight teeth.	To drive rack carrying dial.	2Z4875-370

2. Identification Table of Parts for Signal Generator SG-15/PCM (contd)

Ref Symbol	Name of part and description	Function of part	Signal Corps stock No.
	GEAR ASSEMBLY: c/o two split gears, one pinion gear, and one gear mtg ring.	Oscillator tuning.	2Z4875-371
	GEAR ASSEMBLY: c/o two split gears, one pinion gear, and one mtg ring.	Dial mounting.	2Z4875-372
E6	HOLDER, fuse: extractor post type; black bakelite body w/alloy pl copper term.; 18 amp, 250 v max.	Holder for 2-amp fuse or spare fuse.	3Z1939
J1	JACK, telephone: for twin 2 cond .25" dia plugs.	OUTPUT jack. For connecting output of signal generator to equipment to be tested.	2Z5598-32
	KNOB: round, fluted, w/skirt; black bakelite; white indicator line marking.	COARSE DBM control knob.	2Z5822-248
	KNOB: round, knurled, w/crank handle; black finish phenolic w/metal insert; unmarked.	FREQUENCY control knob.	2Z5822-454
	KNOB: round, fluted; black bakelite; white dot marking.	FINE DBM control knob.	2Z5822-455
E5	LAMP, incandescent: 6-8 v, 15 amp; bulb T-3¼ clear; miniature bayonet base; tungsten filament w/brown bead; No. 47.	Lamp for indicator light.	2Z5952
I-1	LIGHT, indicator: w/red plastic cap lens; for miniature bayonet base T3¼ bulb; inclosed shell.	Lights when power is applied to signal generator.	2Z5991-183
M1	METER, audio level: dc; range 0-1 ma; round metal case; accuracy ±.15 db; D'Arsonval movement; 150 ohms ±20% across term.; 21 scale divisions, black figures on white background.	OUTPUT LEVEL meter. A d-c milliammeter calibrated in db over a range of 10 db. Indicates the difference between the output power of the signal generator and the setting of the COARSE DBM control.	3F3307.5-6
	POINTER, indicator: lucite; 2½" wd x 4⅛" lg x .060" thk.	Hairline indicator for reading FREQUENCY dial.	
E1, E2, E3	POST, binding: thumbscrew type; brass nickel pl cap and base; knurled cap.	E1, E2 — OUTPUT terminals. For connecting output of signal generator to equipment to be tested. E3 — GND terminal. For connecting chassis of signal generator to external ground.	3Z737-19
L3	REACTOR: filter choke; 8 hy, 110 ma; 250-ohm d-c resistance max; 2000 v peak; metal case.	With capacitors C33 and C34, forms a filter network for the output of rectifier tube V13. Reduces the ripple content in the pulsating d-c output of the rectifier.	3C325-19
R25, R26	RESISTOR, fixed: WW; nonreactive; 300 ohms ±1%; 2 w.	With capacitors C22 and C23 and resistor R27, form output impedance network.	3Z6030-137

2. Identification Table of Parts for Signal Generator SG-15/PCM (contd)

Ref Symbol	Name of part and description	Function of part	Signal Corps stock No.
R29, R31, R38	RESISTOR, fixed: comp; 470 ohms ±10%; ½ w; JAN type RC20BF471K.	R29 — Cathode resistor of tube V7. R31 — Cathode resistor of tube V8. R38 — In series with resistor R39, the cathode voltage-dropping resistor of tube V9.	3RC20BF471K
R24	RESISTOR, fixed: comp; 470 ohms ±10%; 2 w; JAN type RC42BF471K.	Common cathode bias resistor of tubes V5 and V6.	3RC42BF471K
R39	RESISTOR, fixed: comp; 680 ohms ±10%; ½w; JAN type RC20BF681K.	In series with resistor R38, a cathode voltage-dropping resistor of tube V9.	3RC20BF681K
R52	RESISTOR, fixed: film; 820 ohms ±1%.	With potentiometer R44, allows initial calibration of the metering circuit. This adjustment is made at the time of manufacture.	
R3, R8, R13	RESISTOR, fixed: comp; 1000 ohms ±10%; ½w; JAN type RC20BF102K.	R3 — Cathode resistor of tube V1. Develops d-c bias for the grid of the tube and an r-f voltage which is fed back to the tank circuit associated with tube V1 to maintain oscillation. R8 — Cathode bias resistor of tube V2. R13 — Cathode bias resistor of tube V3.	3RC20BF102K
R17	RESISTOR, fixed: comp; 3300 ohms ±10%; 1 w; JAN type RC30BF332K.	Cathode bias resistor of tube V4B.	3RC30BF332K
R1, R6	RESISTOR, fixed: comp; 4700 ohms ±10%; ½w; JAN type RC20BF472K.	R1 — Plate load resistor of tube V1. R6 — Plate load resistor of tube V2.	3RC20BF472K
R42, R43	RESISTOR, fixed: film; 4700 ohms ±1%; 1 w; JAN type RC30BF562J.	Reduce the amount of voltage applied to the bridge rectifier circuit to the required level.	3RC30BF562J
R19	RESISTOR, fixed: comp; 5600 ohms ±10%; ½ w; JAN type RC20BF562K.	Connects the tertiary of transformer T2 to tube V4A in a negative feedback arrangement. Reduces the output impedance of transformer T2.	3RC20BF562K
R27	RESISTOR, fixed: WW; 7500 ohms; JAN type RC30BF752J.	With resistors R25 and R26 and capacitors C22 and C23, forms an output impedance network.	
R16	RESISTOR, fixed: comp; 8200 ohms ±10%; ½ w; JAN type RC20BF822K.	Cathode bias resistor of tube V4A.	3RC20BF822K
R37	RESISTOR, fixed: comp; 10,000 ohms ±10%; ½ w; JAN type RC20BF103K.	With capacitor C27A, filters d-c voltage for grid 3 of tube V9.	3RC20BF103K

2. Identification Table of Parts for Signal Generator SG-15/PCM (contd)

Ref Symbol	Name of part and description	Function of part	Signal Corps stock No.
R2, R7	RESISTOR, fixed: film; 10,000 ohms ±1%.	R2 — Connects cathode of tube V1 to tank circuit associated with that tube in a feedback arrangement to maintain oscillation. R7 — Cathode feedback resistor of tube V2.	
R47	RESISTOR, fixed: comp; 22,000 ohms; JAN type RC40BF223K.	Drops voltage applied to tube V11 to the level required for operation of the tube.	
R34, R40	RESISTOR, fixed: comp; 22,000 ohms; JAN type RC20BF223J.	R34 — With resistor R30, the voltage divider through which the output of the secondary of transformer T1 is applied to control grid 1 of mixer tube V9. R40 — Plate load resistor of tube V9.	
R12, R33	RESISTOR, fixed: comp; 27,000 ohms ±10%; JAN type RC30BF273K.	R12 — Plate load resistor of tube V3. R33 — Plate load resistor of tube V8.	3RC30BF273K
R5	RESISTOR, fixed: comp; 39,000 ohms ±10%; ½ w; JAN type RC20BF393K.	With resistor R4, voltage divider for output of tube V1.	3RC20BF393K
R41	RESISTOR, fixed: comp; 47,000 ohms ±10%; JAN type RC30BF473K.	Screen-dropping resistor of tube V9.	
R15, R18, R35, R51	RESISTOR, fixed: comp; 47,000 ohms ±10%; JAN type RC20BF473K.	R15 — Plate load resistor of tube V4A. R18 — Plate load resistor of tube V4B. R35 — With resistor R36, voltage divider for output of tube V8. R51 — With resistor R49 and potentiometer R50, a voltage divider between the output of tube V12 and ground.	3RC20BF473K
R49	RESISTOR, fixed: comp; 68,000 ohms; JAN type RC20BF683M.	With potentiometer R50 and resistor R51, voltage divider between the output of tube V12 and ground.	
R9, R10	RESISTOR, fixed: comp; 82,000 ohms ±10%; ½ w; JAN type RC20BF823K.	Voltage-dividing network for output of tube V2. The signal at the junction of these resistors is applied to grid 1 of tube V8.	3RC20BF823K

2. Identification Table of Parts for Signal Generator SG-15/PCM (contd)

Ref Symbol	Name of part and description	Function of part	Signal Corps stock No.
R45, R46	RESISTOR, fixed: comp; 82,000 ohms ±10%; JAN type RC30BF393J.	R45 — With capacitor C31A, forms a filter network for tube V1. R46 — With capacitor C31B, forms a filter network for tube V1.	
R28, R32	RESISTOR, fixed: comp; 100,000 ohms ±10%; JAN type RC20BF472K.	R28 — Screen-dropping resistor of tube V7. R32 — Screen-dropping resistor of tube V8.	
R4, R36	RESISTOR, fixed: comp; 220,000 ohms ±10%; ½ w; JAN type RC20BF224K.	R4 — With resistor R5, voltage divider for output of tube V1. The attenuated signal at the junction of these resistors is applied to tube V7. R36 — With resistor R35, voltage divider for output of tube V8.	3RC20BF224K
R14, R21, R22, R23	RESISTOR, fixed: comp; 560,000 ohms ±10%; ½ w; JAN type RC20BF564K.	R14 — Grid resistor of tube V4A. R21 — Grid resistor of tube V5. Also, with resistor R22 and capacitor C19, forms an a-c voltage divider of the output of tube V4A. R22 — Voltage-dropping resistor for tubes V4A and V4B. R23 — Grid resistor of tube V6. Also, with resistor R22 and capacitor C21, forms an a-c voltage divider of the output of tube V4B.	3RC20BF564K
R30	RESISTOR, fixed: comp; 560,000 ohms; JAN type RC20BF564J.	With resistor R34, a voltage divider through which the output of the secondary of transformer T1 is applied to control grid 1 of mixer tube V9.	
R20, R48	RESISTOR, fixed: comp; 1.2 meg ±10%; ½ w; JAN type RC20BF125K.	R20 — Grid resistor of tube V4B. R48 — Plate load resistor of tube V10.	3RC20BF125K
R44	RESISTOR, variable: WW; 200 ohms ±10%; 2 w; JAN type RA20A15A201AK.	METER ADJ potentiometer. With resistor R52, allows initial calibration of the metering circuit. This adjustment is made at the time of manufacture.	

2. Identification Table of Parts for Signal Generator SG-15/PCM (contd)

Ref Symbol	Name of part and description	Function of part	Signal Corps stock No.
R11	RESISTOR, variable: comp; 10,000 ohms ±10%; 2 w; JAN type RV4ANFK103A.	FINE DBM potentiometer. Permits control of the amplitude of the signal applied to tube V3 from filter Z1.	3RV41510
R50	RESISTOR, variable: comp; 50,000 ohms ±10%; 2 w.	B+ ADJ potentiometer. Sets operating level of regulated +250-volt supply circuit. Also, with resistors R49 and R51, a voltage divider between the output of tube V12 and ground.	
X1 thru X13	SOCKET, tube: octal; JAN type TSB8T101.	Socket for tubes V1 through V13.	2Z8678.326
S1	SWITCH, toggle: DPDT; JAN type ST22N.	PRIMARY VOLTAGE switch. In the 115 V position, connects the two sections of the primary of power transformer T3 in parallel for operation on a 230-volt line. In the 230 V position, connects the two sections of the primary in series for operation on a 230-volt line.	3Z9849.135
S2	SWITCH, toggle: DPST; JAN type ST22K.	Power ON-OFF switch. In the ON position, applies line voltage to the primary of power transformer T3.	3Z9863-22K
T2	TRANSFORMER, AF: plate coupling type; impedance — pri 13,000 ohms CT at 3125 ohms, secd 1000 ohms CT, tertiary 25 ohms; metal case.	Output transformer. Couples the output of power amplifier tubes V5 and V6 to the input of attenuator E4.	2Z9632.588
T3	TRANSFORMER, power: filament and plate type; 115/230 v, 50-60 cyc, single ph; 4 output wdg — secd, No. 1, 6.3 v at 3.6 amp; secd No. 2, 6.3 v at .9 amp; secd No. 3, 5 v at 2 amp; secd No. 4, 750 v at 110 ma; insulation — secd No. 1, 1000 v; secd No. 2, 2000 v; secd No. 3, 2500 v; secd No. 4, 2500 v; metal case.	Power transformer.	2Z9608-121
T1	TRANSFORMER, IF: 100 kc; interstage; shielded; double tuned; adjustable iron core tuning.	Interstage transformer. Applies the output of tube V7 to mixer circuit.	2Z9636.152
V1, V2, V3	TUBE, electron: type 6J5; pentode.	V1 — Fixed frequency oscillator. V2 — Variable frequency oscillator. V3 — 3d amplifier.	2J6J5

2. Identification Table of Parts for Signal Generator SG-15/PCM (contd)

Ref Symbol	Name of part and description	Function of part	Signal Corps stock No.
V7, V8	TUBE, electron: type 6SJ7; pentode.	V7 — 1st amplifier. V8 — 2d amplifier.	2J6SJ7
V9	TUBE, electron: type 6SA7Y; pentagrid converter.	Mixer tube.	2J6SA7Y
V4	TUBE, electron: type 6SL7GT; twin triode.	V4A — 4th amplifier. V4B — Phase inverter.	2J6SL7GT
V5, V6	TUBE, electron: type 6V6Y; beam power.	Power amplifiers.	2J6V6Y
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V10	TUBE, electron; type 6SQ7; duplex diode.	Voltage control amplifier.	2J6SQ7
V11	TUBE, electron: type OC3/VR105; glow discharge diode.	Voltage control regulator.	2JOC3/VR105
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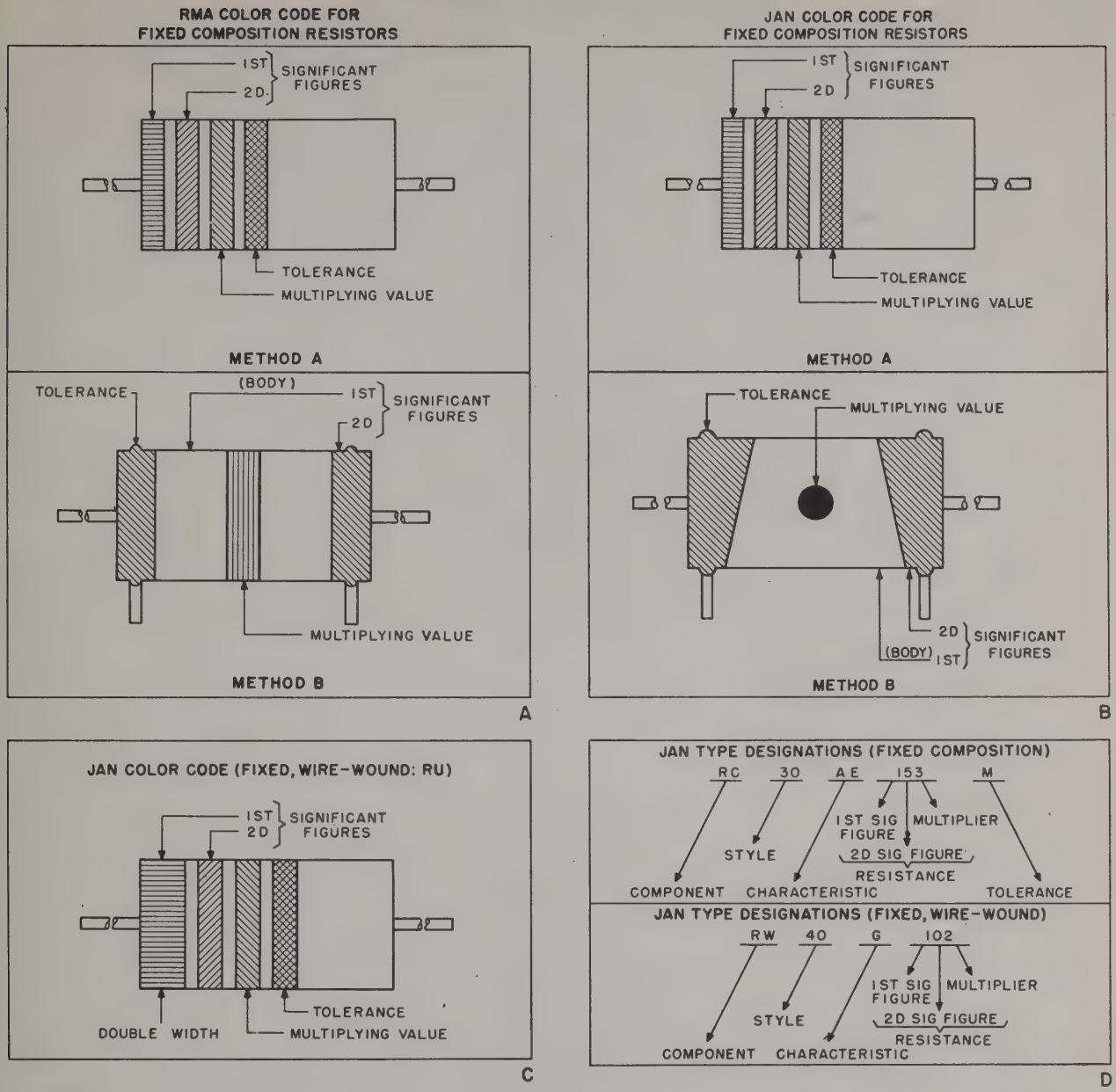
RESISTOR COLOR AND LETTER CODE



STANDARDS				
COLOR	SIGNIFICANT FIGURE	MULTIPLYING VALUE	TOLERANCE (%)	JAN LETTER TOLERANCE
BLACK	0	1	–	–
BROWN	1	10	± 1	F
RED	2	100	± 2	G
ORANGE	3	1,000	± 3	–
YELLOW	4	10,000	± 4	–
GREEN	5	100,000	± 5	–
BLUE	6	1,000,000	± 6	–
VIOLET	7	10,000,000	± 7	–
GRAY	8	100,000,000	± 8	–
WHITE	9	1,000,000,000	± 9	–
GOLD	–	0.1	± 5	J
SILVER	–	0.01	±10	K
NO COLOR	–	–	±20	M

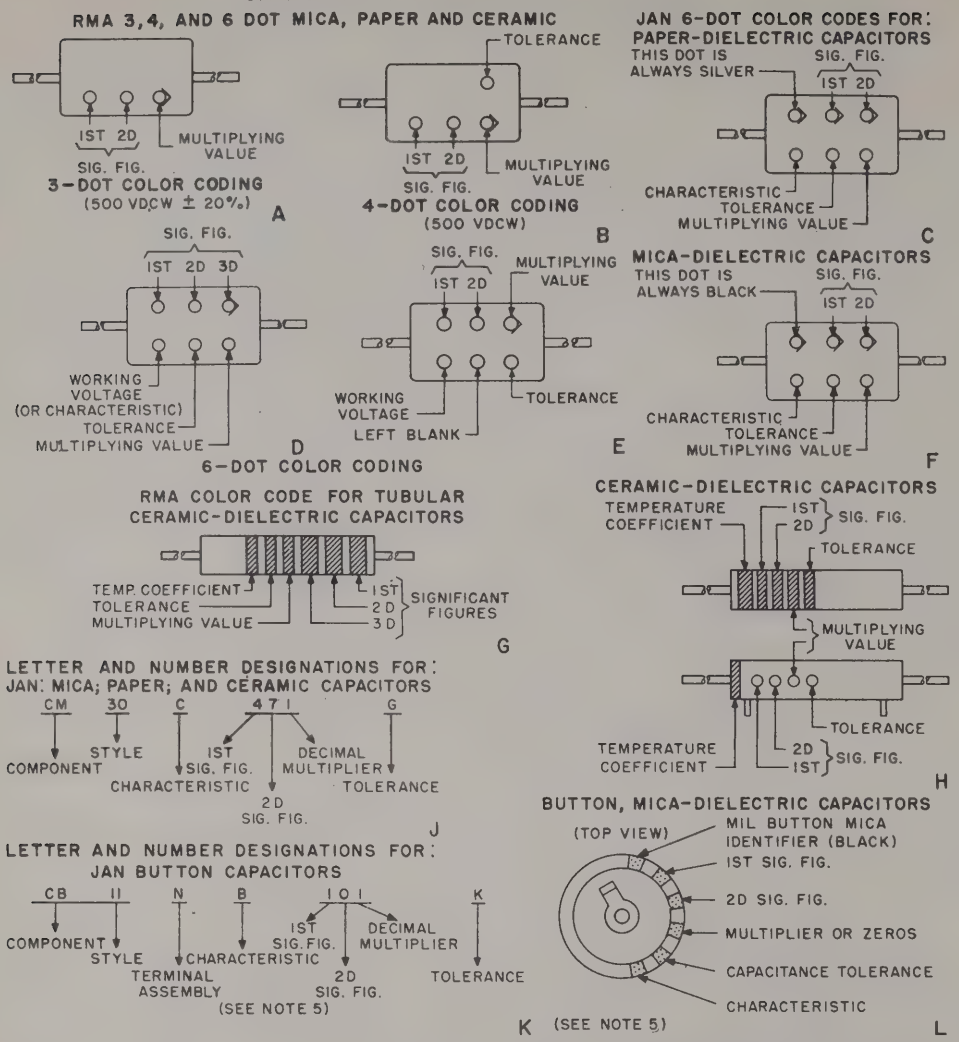
NOTES:

1. RESISTORS WITH AXIAL LEADS ARE INSULATED. RESISTORS WITH RADIAL LEADS ARE NON-INSULATED.
2. RMA: RADIO MANUFACTURERS ASSOCIATION.
3. JAN: JOINT ARMY-NAVY.
4. THESE COLOR AND NUMBER CODES GIVE ALL RESISTANCE VALUES IN OHMS.
5. RESISTIVE COMPONENTS USED FOR LETTER TOLERANCES ARE: RC, RN, AND RU.
6. WATTAGE FOR RW TYPES IS FOUND IN THE JAN SPECIFICATIONS UNDER CHARACTERISTICS.

TM RC

Figure 27. Resistor color codes.

CAPACITOR COLOR AND LETTER CODES



- STANDARDS -					JAN MICA-CM		JAN PAPER-CN		JAN CERAMIC-CC					
										CAP. TOL. FOR MORE THAN 10 UUF		CAP. TOL. FOR 10 UUF OR LESS		
COLOR	SIG. FIG.	DECIMAL MULTIPLIER	% TOL.	VDCW	LETTER TOL.	CHARACTERISTIC	LETTER TOL.	CHARACTERISTIC	DEC. MULT.	%	LETTER DESIGNATION	UUF	LETTER DESIGNATION	CHARACTERISTIC
BLACK	0	1	±20	500	M	A	M	A	1	±20	M	±2.0	G	C
BROWN	1	10	± 1	100	-	B	-	E	10	± 1	F	-	-	H
RED	2	100	± 2	200	G	C	-	H	100	± 2	G	-	-	L
ORANGE	3	1,000	± 3	300	-	D	N*	J	1,000	-	-	-	-	P
YELLOW	4	10,000	± 4	400	-	E	-	P	-	-	-	-	-	R
GREEN	5	100,000	± 5	500	-	F	-	R	-	± 5	J	±0.5	D	S
BLUE	6	1,000,000	± 6	600	-	G	-	S	-	-	-	-	-	T
VIOLET	7	10,000,000	± 7	700	-	-	-	T	-	-	-	-	-	U
GRAY	8	100,000,000	± 8	800	-	-	-	-	0.01	-	-	±0.25	C	B
WHITE	9	1,000,000,000	± 9	900	-	-	-	-	0.1	± 10	K	±1.0	F	SL
GOLD	-	0.1	± 5	1,000	J	-	-	-	-	-	-	-	-	A
SILVER	-	0.01	±10	2,000	K	-	K	-	-	-	-	-	-	-
NO COLOR	-	-	±20	500	-	-	-	-	-	-	-	-	-	-
* THE TOLERANCE OF THIS CAPACITOR IS ±30%, NOT ±3%														

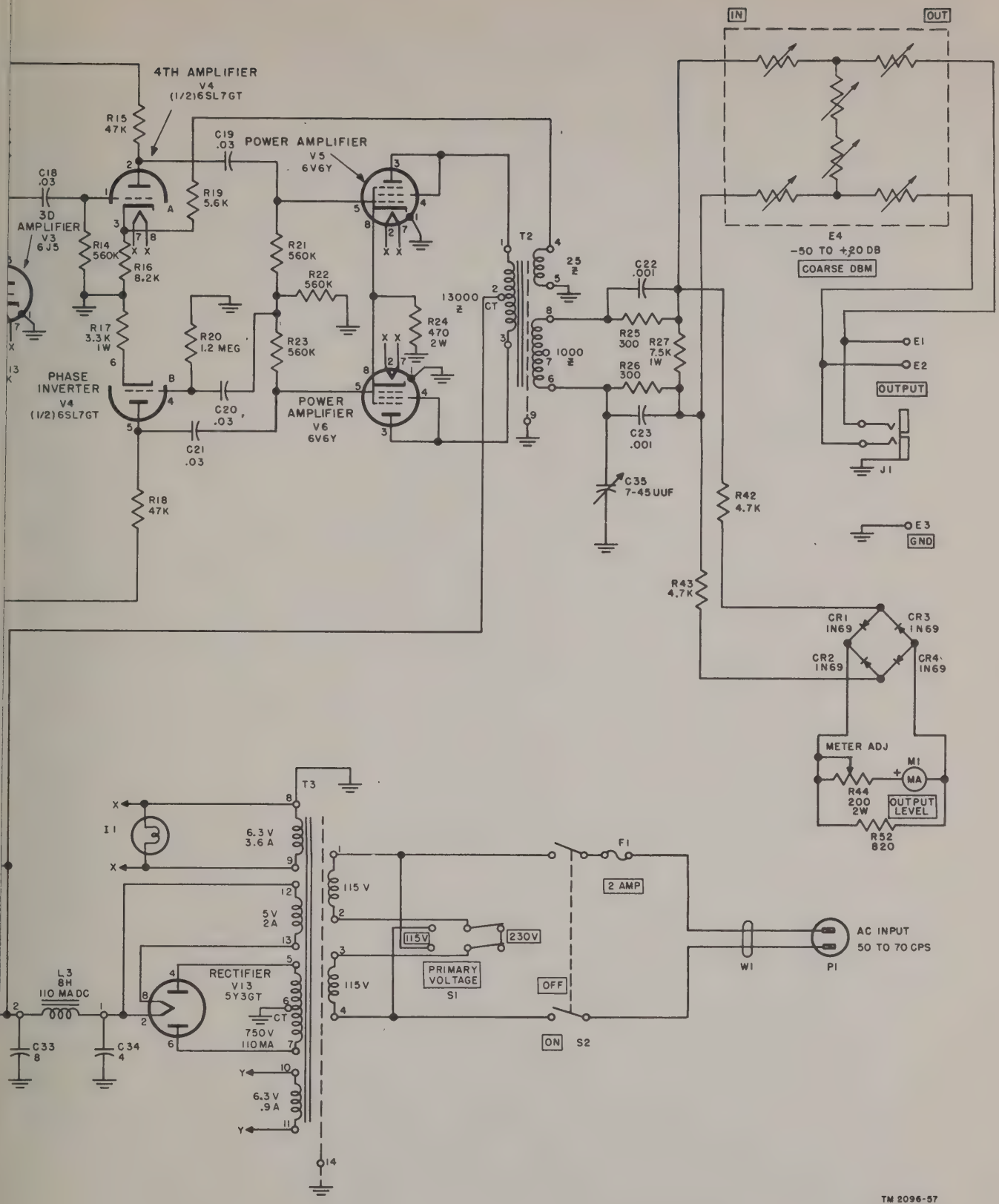
NOTES

JAN: JOINT ARMY-NAVY
RMA: RADIO MANUFACTURERS ASSOCIATION

1. THESE COLOR AND LETTER CODES GIVE CAPACITANCES IN MICROMICROFARADS
2. THIS TABLE IS ADAPTED FOR JAN AND RMA COLOR AND JAN LETTER TYPE DESIGNATIONS
3. CERAMIC AND MICA CAPACITORS, BOTH JAN AND RMA, ARE GENERALLY 500 VDCW
4. BUTTON CAPACITORS ARE GENERALLY 300 VDCW
5. READ BUTTON CAPACITOR TOLERANCE UNDER CERAMICS OF MORE THAN 10 UUF
6. CHARACTERISTICS ARE AVAILABLE IN JAN CAPACITOR SPECIFICATION MANUALS
7. THE COMPONENTS USED ABOVE FOR JAN LETTER TYPE DESIGNATIONS ARE:
   CB MICA BUTTON: *CC* CERAMIC; *CM* MICA MOULDED: *CN* PAPER MOULDED

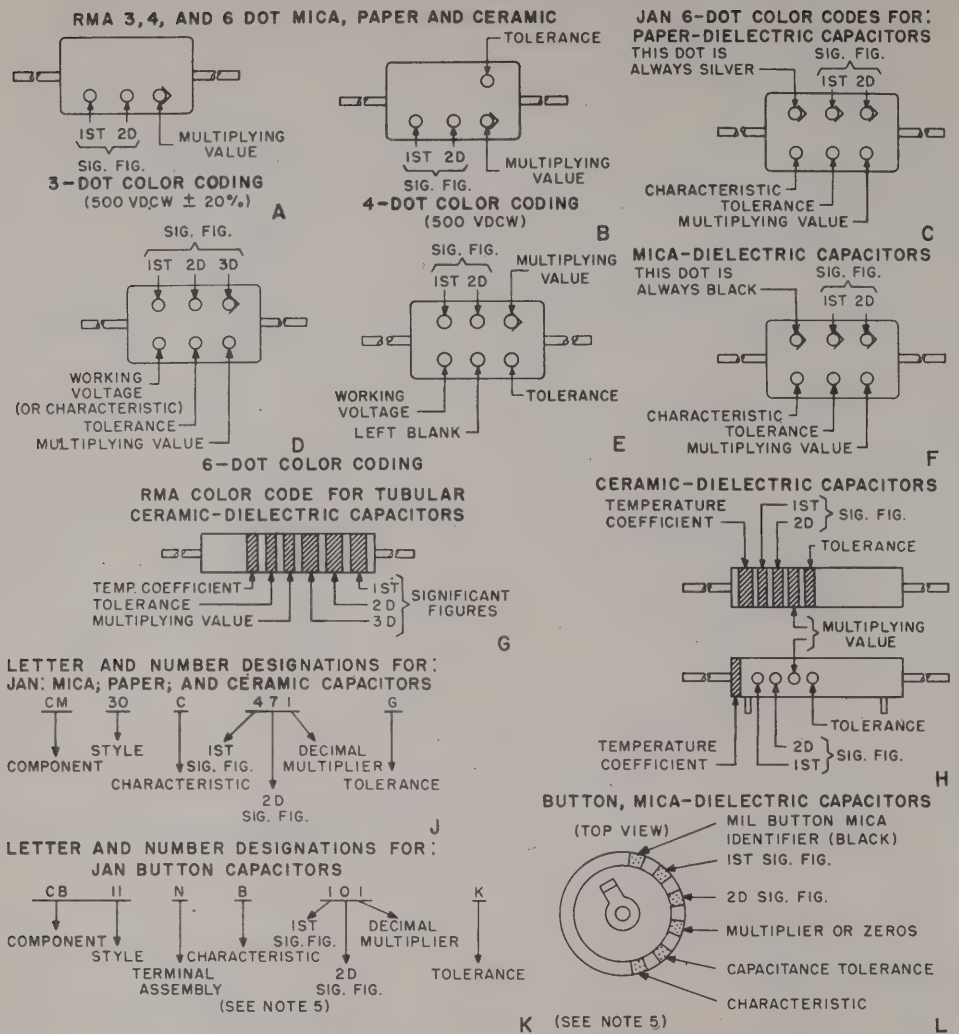
TM CC

Figure 28. Capacitor color codes.



M, schematic diagram.

CAPACITOR COLOR AND LETTER CODES



- STANDARDS -					JAN MICA-CM		JAN PAPER-CN		JAN CERAMIC-CC					
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BLACK	0	1	±20	500	M	A	M	A	1	±20	M	±2.0	G	C
BROWN	1	10	± 1	100	-	B	-	E	10	± 1	F	-	-	H
RED	2	100	± 2	200	G	C	-	H	100	± 2	G	-	-	L
ORANGE	3	1,000	± 3	300	-	D	N*	J	1,000	-	-	-	-	P
YELLOW	4	10,000	± 4	400	-	E	-	P	-	-	-	-	-	R
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BLUE	6	1,000,000	± 6	600	-	G	-	S	-	-	-	-	-	T
VIOLET	7	10,000,000	± 7	700	-	-	-	T	-	-	-	-	-	U
GRAY	8	100,000,000	± 8	800	-	-	-	-	0.01	-	-	±0.25	C	B
WHITE	9	1,000,000,000	± 9	900	-	-	-	-	0.1	± 10	K	±1.0	F	SL
GOLD	-	0.1	± 5	1,000	J	-	-	-	-	-	-	-	-	A
SILVER	-	0.01	±10	2,000	K	-	K	-	-	-	-	-	-	-
NO COLOR	-	-	±20	500	-	-	-	-	-	-	-	-	-	-
* THE TOLERANCE OF THIS CAPACITOR IS ±30%, NOT ±3%														

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Figure 28. Capacitor color codes.

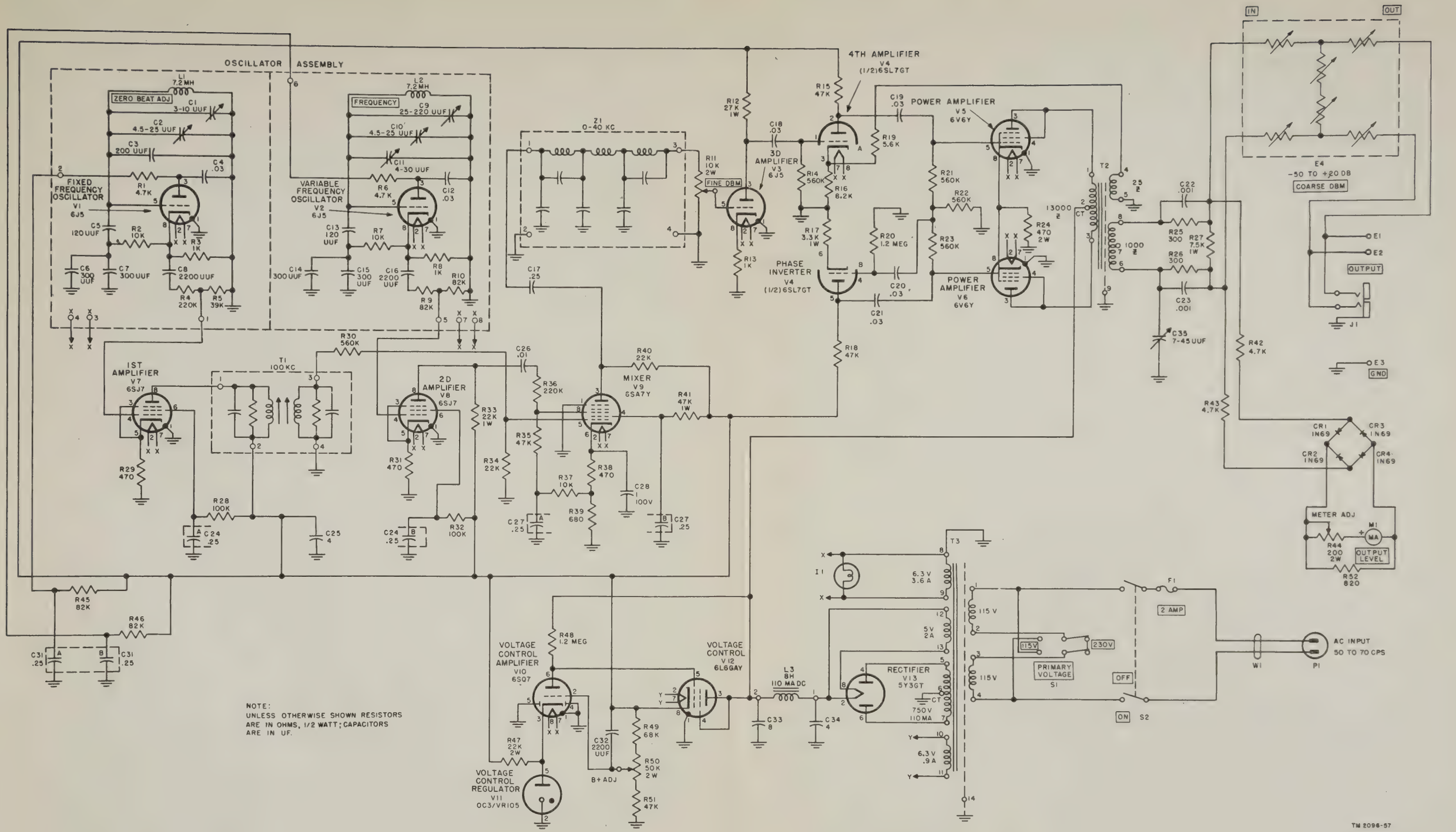
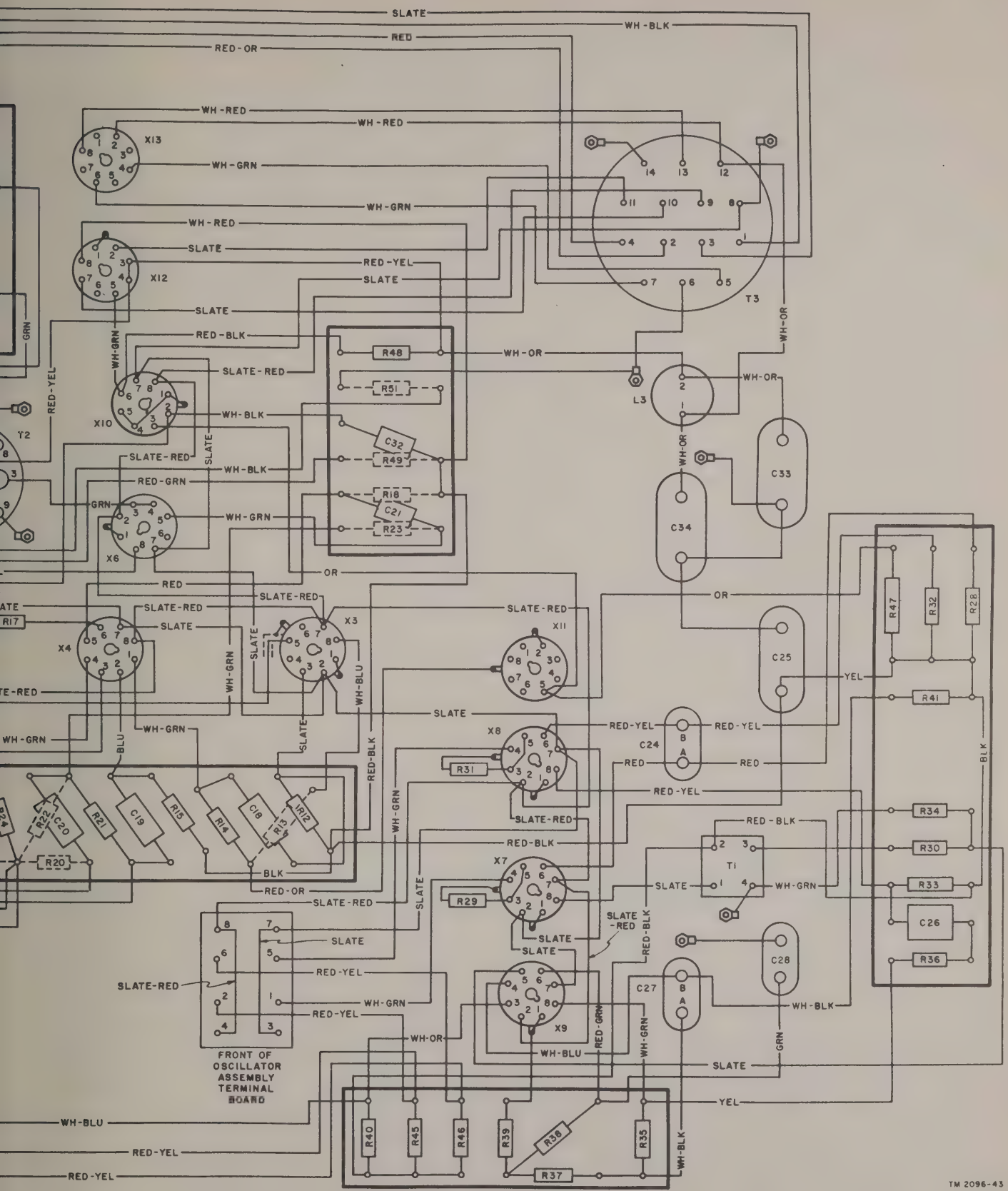


Figure 29. Signal Generator SG-15/PCM, schematic diagram.



SG-15/PCM, wiring diagram.

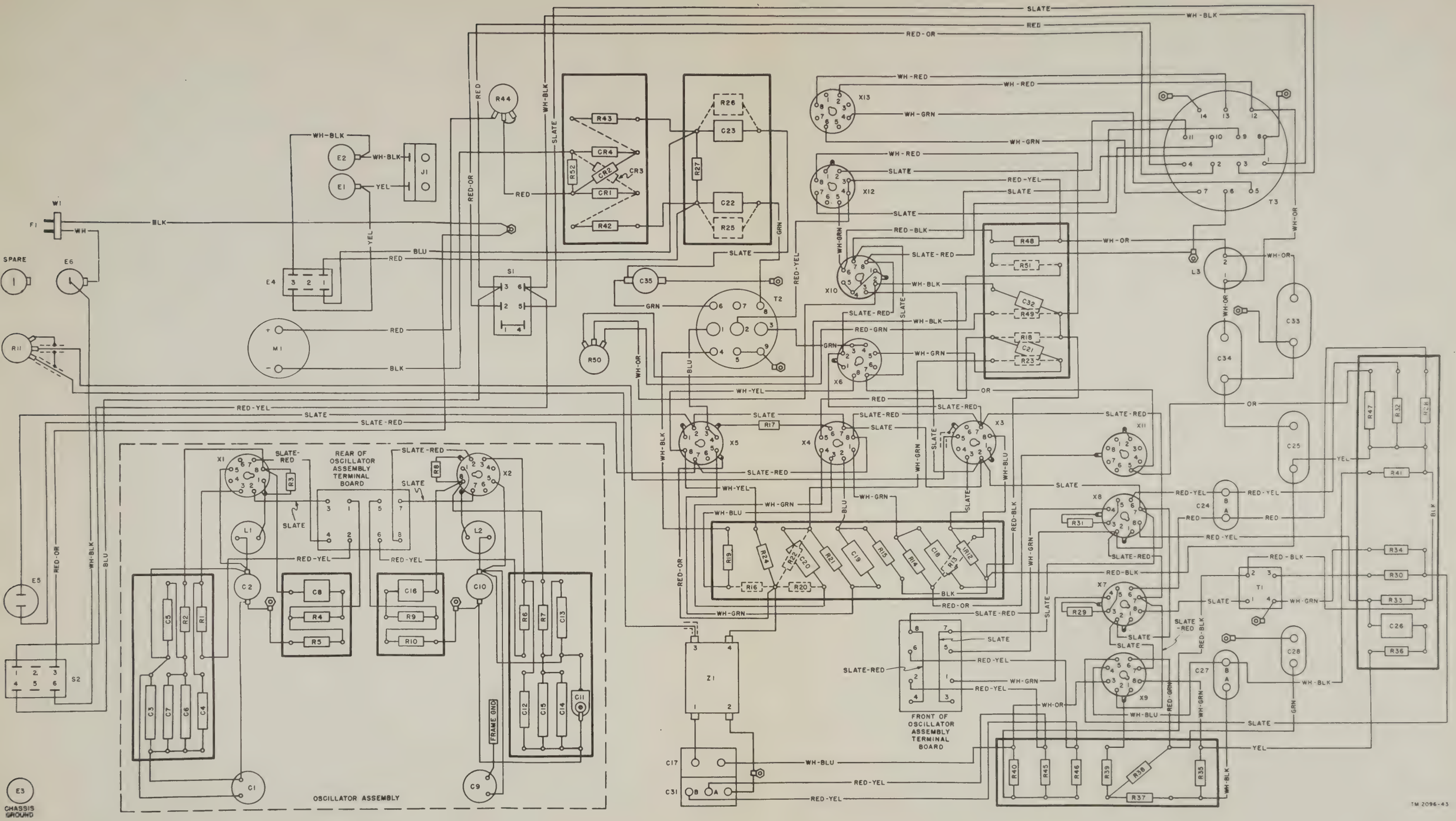


Figure 30. Signal Generator SG-15/PCM, wiring diagram.